NASA Advisory Council
Space Operations Committee

NASA Headquarters

April 16, 2009

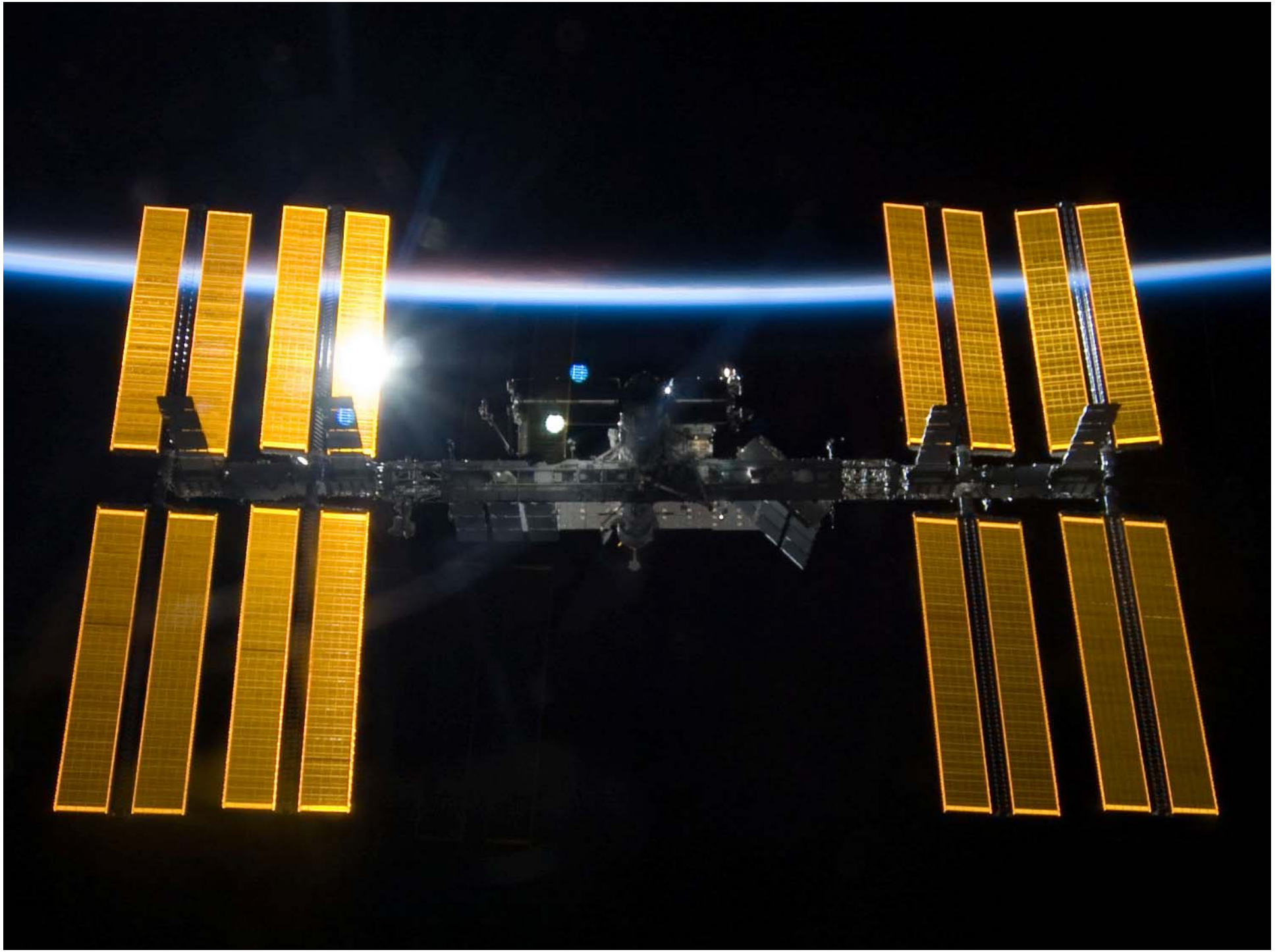
Space Operations Committee

- Col. Eileen Collins, Chair
- Dr. Pat Condon
- Dr. Owen Garriott
- Mr. Jay Greene
- Dr. Tom Jones
- Adm. Benjamin Montoya

- Jacob Keaton, Executive Secretary, NASA

Summary of Activities

- ISS Status
- Space Shuttle Manifest Update
- Orbital Debris Update
- Orbital Sciences Corporation Facility Visit
- ISS Research Program Plan Update



ISS Program Update

- Complete ISS Assembly
  - All U.S.-built elements are on-orbit
  - Final power system element (S6 solar array) delivered and activated
  - Two major elements remain: Node 3, Japanese External Research Facilities
- On track to achieve 6 crew capability – May 2009 Soyuz Launch
  - Environmental and Life Support Systems activated
  - Water Recovery System (including the Urine Processor Assembly) is on-orbit and functional
- Continuing crew/cargo flight planning
  - 2 Soyuz crew exchanges per year
  - 3-4 Progress cargo re-supply flights per year
  - Japanese HII Transfer Vehicle (HTV) scheduled for September 2009
- Continuing to pre-position critical system spares and outfit laboratories with remaining Shuttle flights

Flight Assignment Working Group (FAWG) Planning Manifest

NASA Official: John Coggeshall
USA Project Lead: Barton K. Gibson
Chart updated: 2-Apr-2009

Space Shuttle Program

CY2009 | CY2010
FY2009 | FY2010

103 Discovery
119 (15A)
3/15/09
S6

128 (17A) 8/6 (8/13) (13+1) 3 EVAs — Last Shuttle Crew Rotation — MPLM(P) LMC — ET-132

131 (19A) 3/18 (12+1) 3 EVAs — MPLM(P) LMC — ET-135

134 (ULF6) 9/16 — ELC3 AMS-02 — ET-138

104 Atlantis
122 (1E)
2/7/08
ICC-Lite
Columbus
Module

125 (HST-SM4) 5/12 (11) — SLIC ORUC FSS MULE — ET-130

Ares I-X 7/30

129 (ULF3) 11/12 (11+1) 3 EVAs — ELC1 ELC2 — ET-133

132 (ULF4) 5/13 (11+1) 3 EVAs — ICC-VLD MRM1 — ET-136

135 (LON 134) 11/7 — ET-122

105 Endeavour
126 (ULF2)
11/14/08
MPLM (P)
LMC

127 (2J/A) 6/13 (15+1) 5 EVAs — JEM EF ELM-ES ICC-VLD — ET-131

400 5/19

130 (20A) 2/4 (12+1) 3 EVAs — Cupola Node3 — ET-134

133 (ULF5) 7/29 — ELC4 MPLM(P) — ET-137

This chart represents cargo bay configurations approved by the JCAWG

Hardware available to support 6-person crew on ISS

6-person crew presence on ISS following Soyuz 19S (May 2009)

Flight Rate: FY-5 / CY-6 | FY-5 / CY-4

Launch Beta Angle Cutouts®

Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov

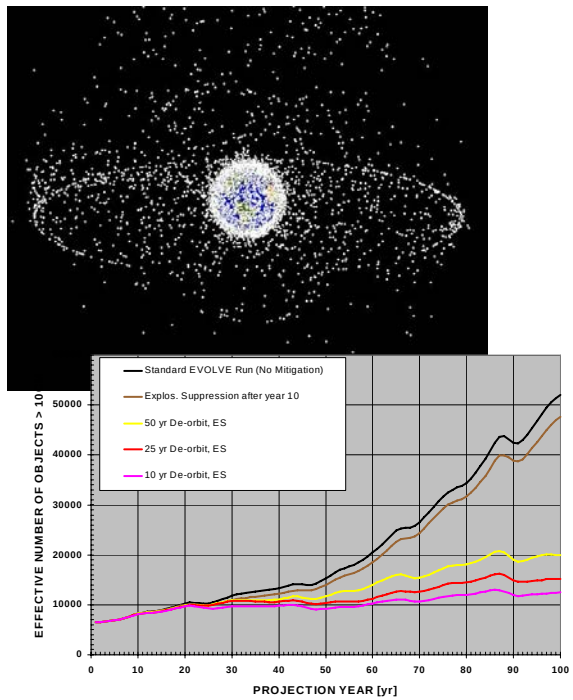
25 β 14 | 21 β 11 | 18 β 8 | Beta Exceedance

STS# (ISS#) Launch Date
FORD Launch Date
Crew Rotation
Mission duration (##)
Number of EVAs (#EVAs)
# of times this OV has flown
Assessed launch date
Launch Pad
External Tank ET-###
Rendezvous Altitude (nmi)
Not baselined in the FORD
Contingency Shuttle Crew Support (CSCS) (Empty Cargo Bay)

19S 5/27 — 33P 5/7
Falcon 9 COTS Demo 1 — Jul 34P 7/24
HTV1 9/1
20S 9/30 — 35P 10/15
MRM2 — 5R 11/10
21S 12/7 — 36P 12/26
37P 2/3
Falcon 9 COTS Demo 2 — Mar
22S 4/2 — 38P Apr
23S May — 39P Jun
Falcon 9 COTS Demo 3 — ATV2 Jun — HTV2 Jul — Jun
24S Sep
25S Nov — 40P Oct — 41P Dec

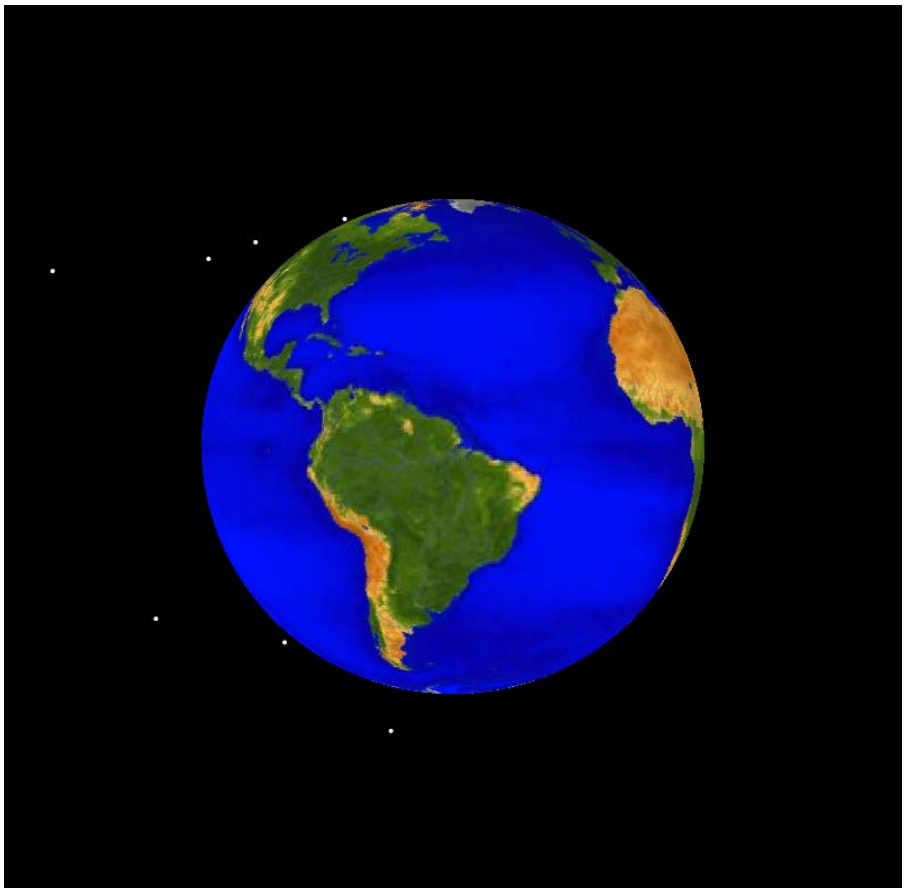
Orbital Debris Update

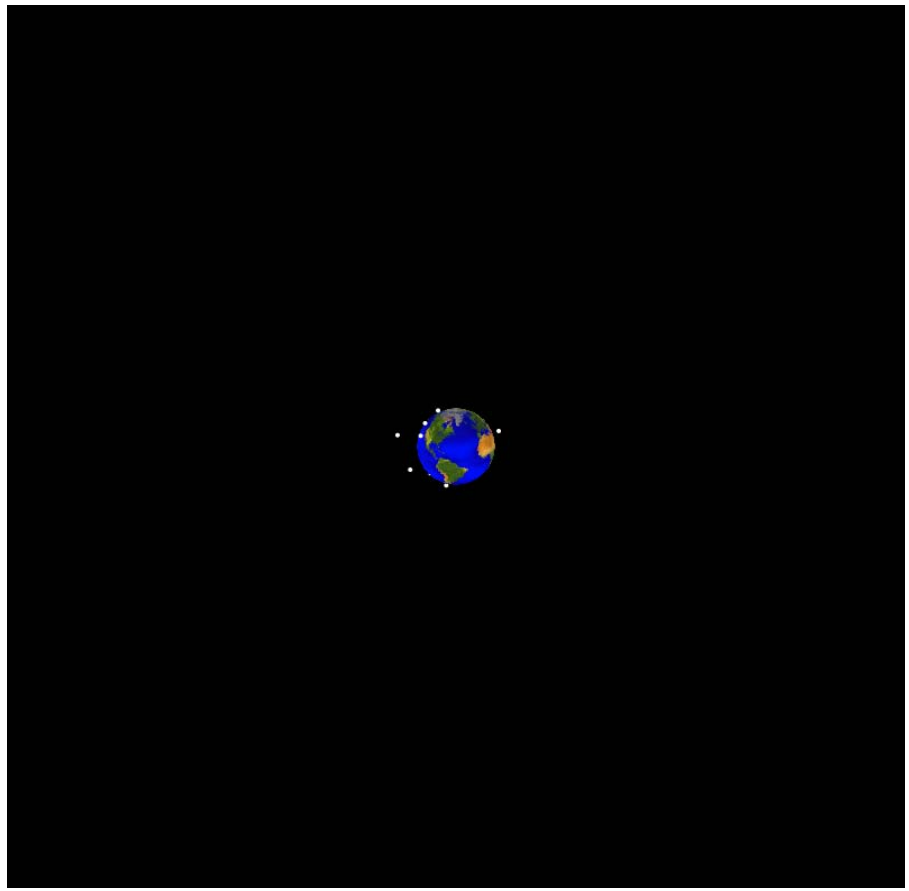
Briefing by Gene Stansbery, Orbital Debris Program Office, JSC



Growth of the Earth Satellite Population

1960

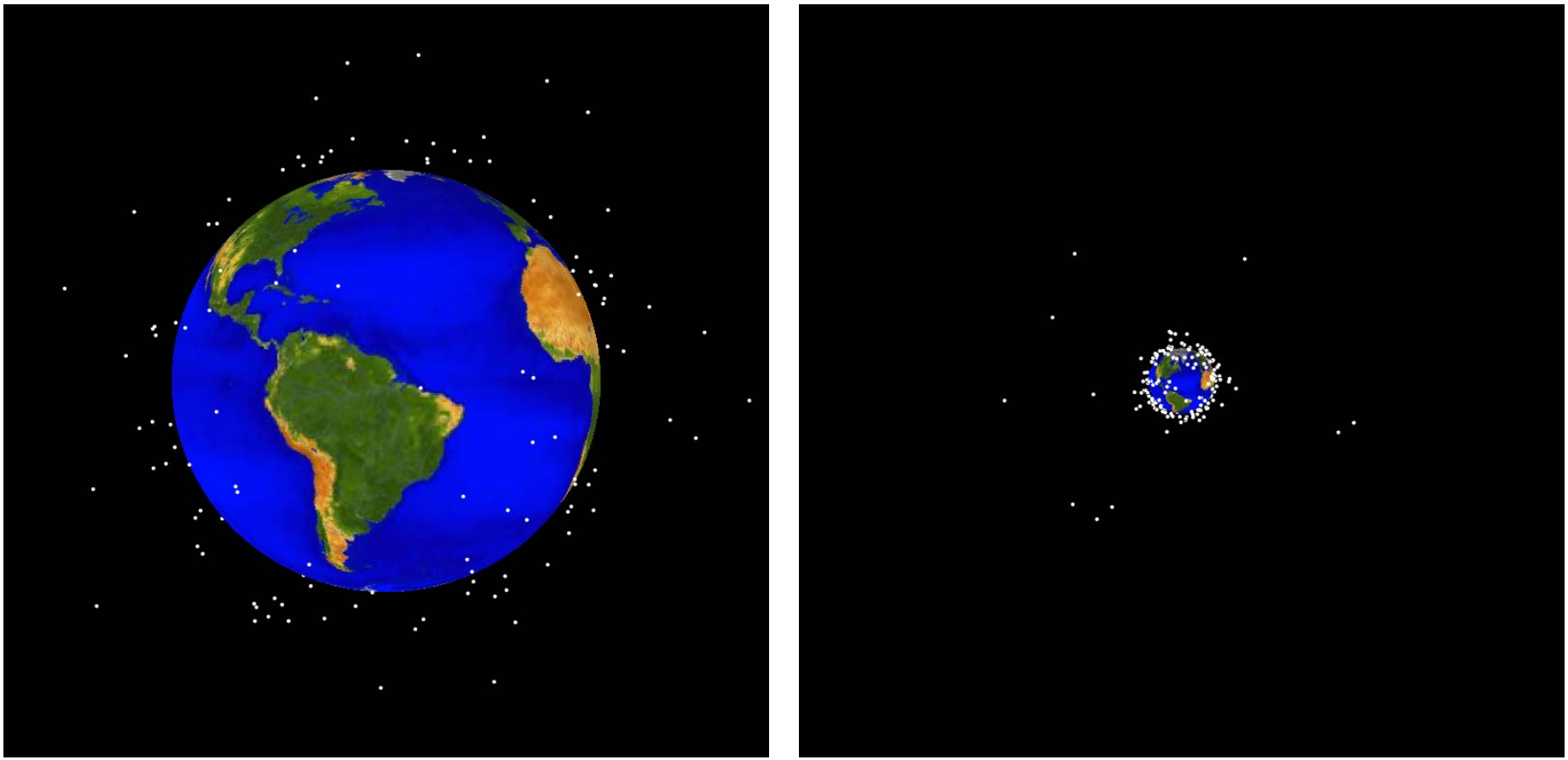




Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

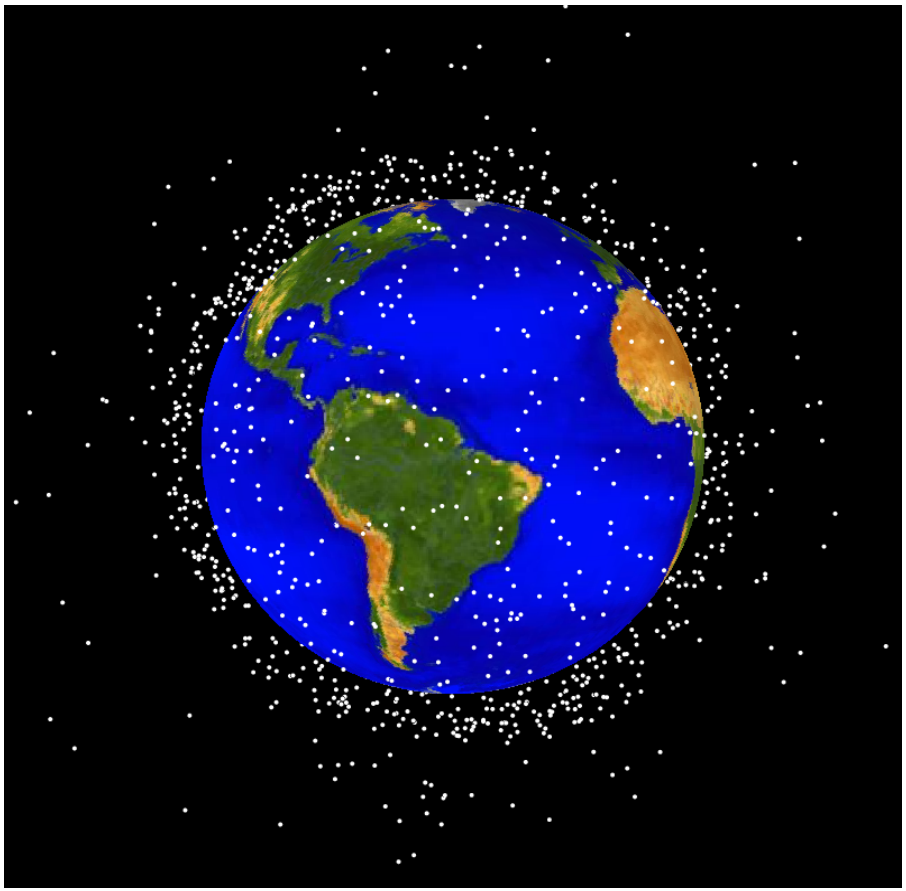
1965

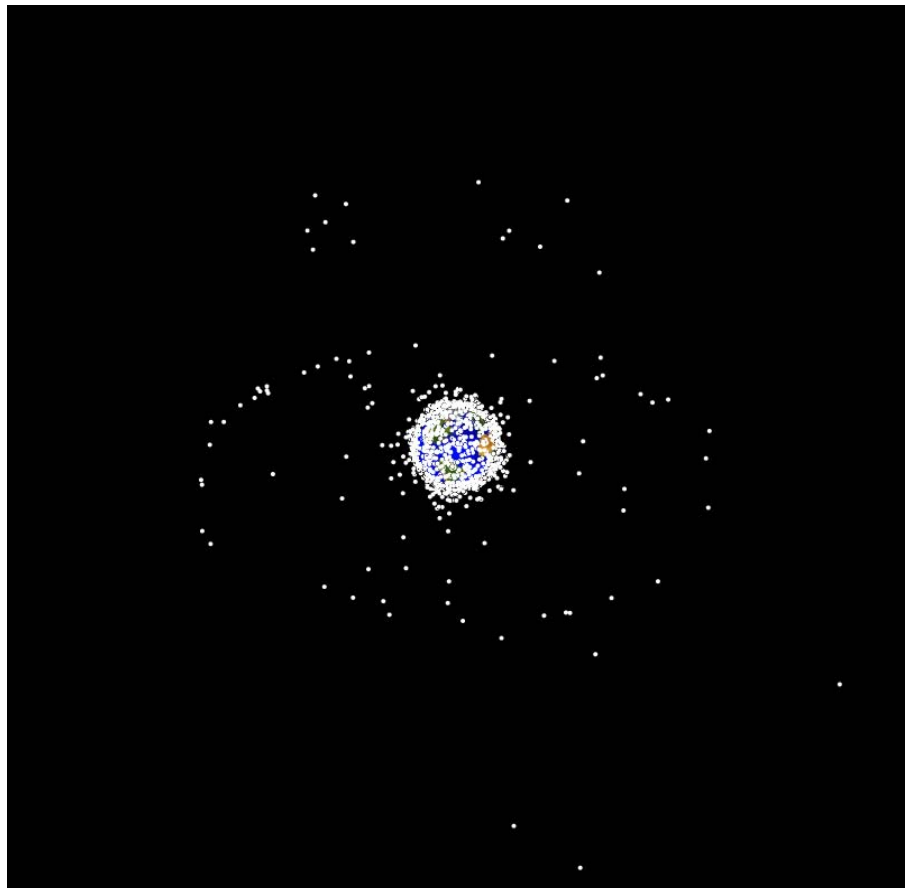


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1970

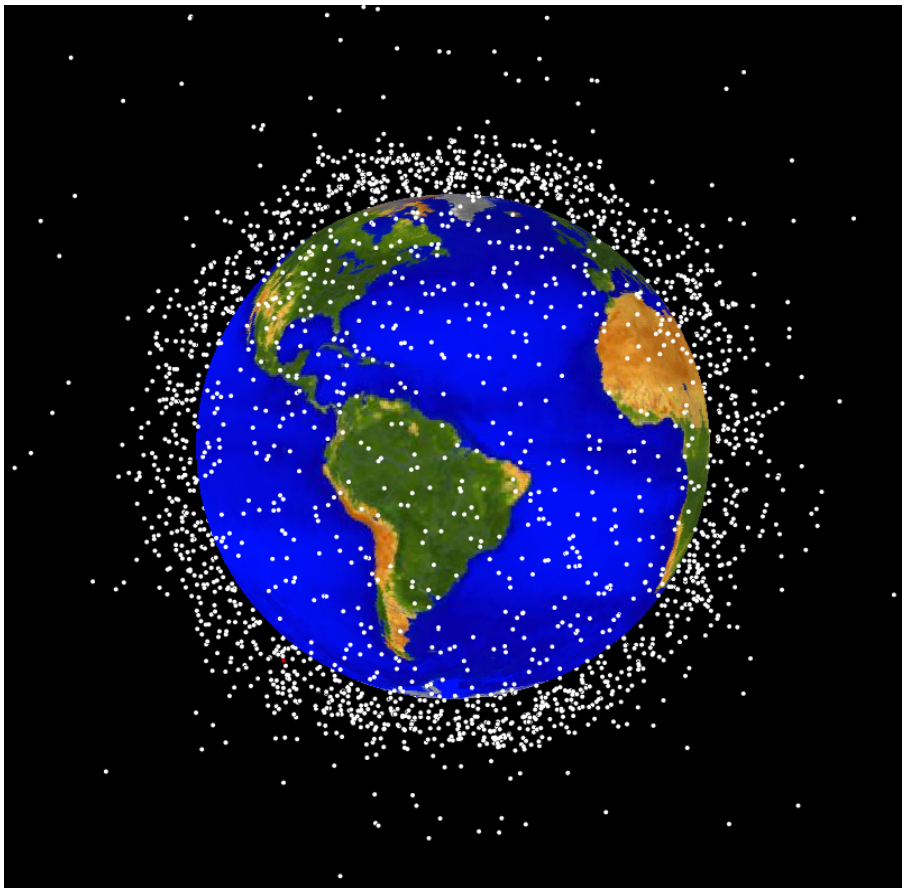


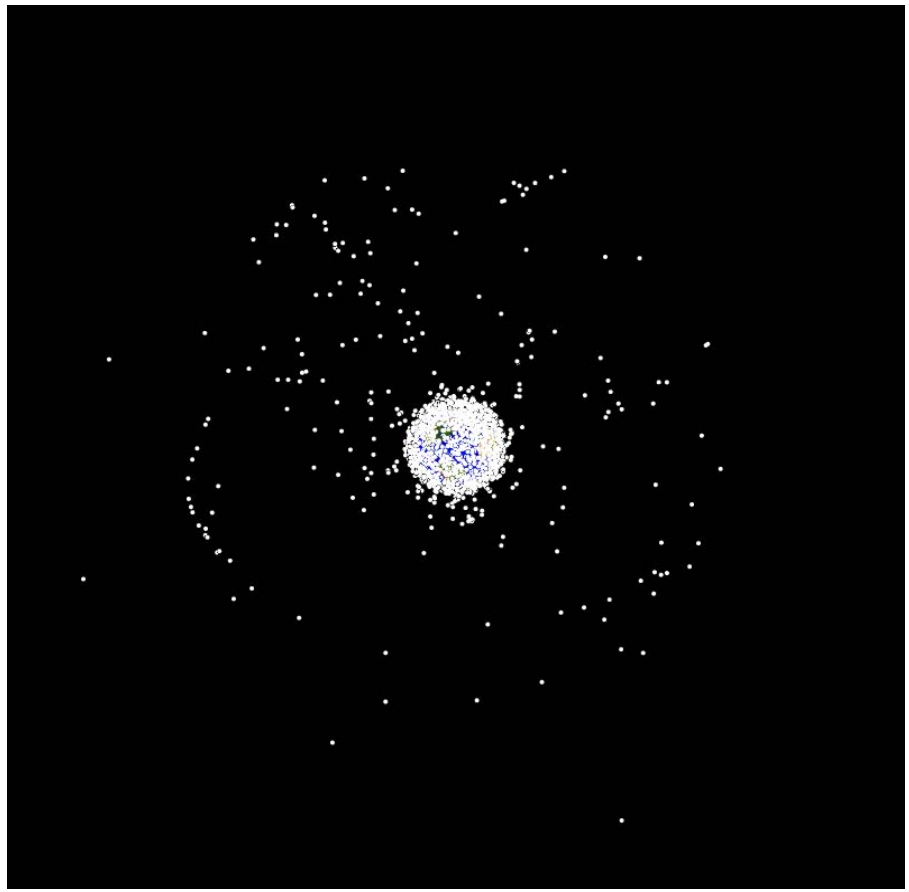


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1975

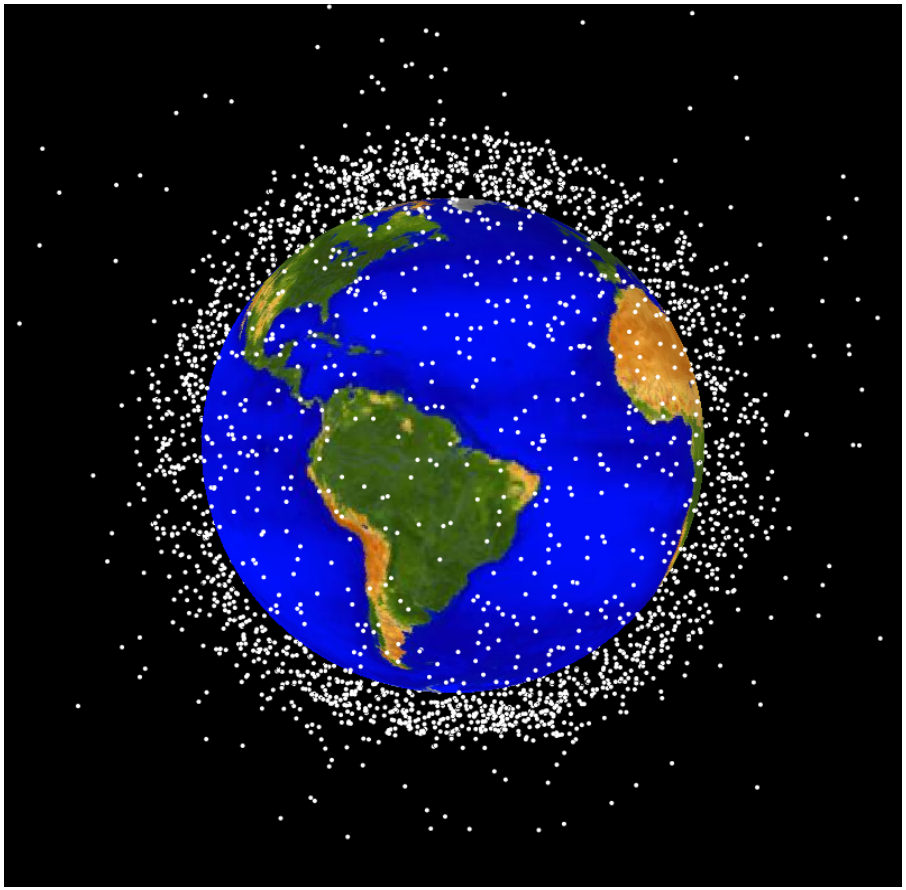


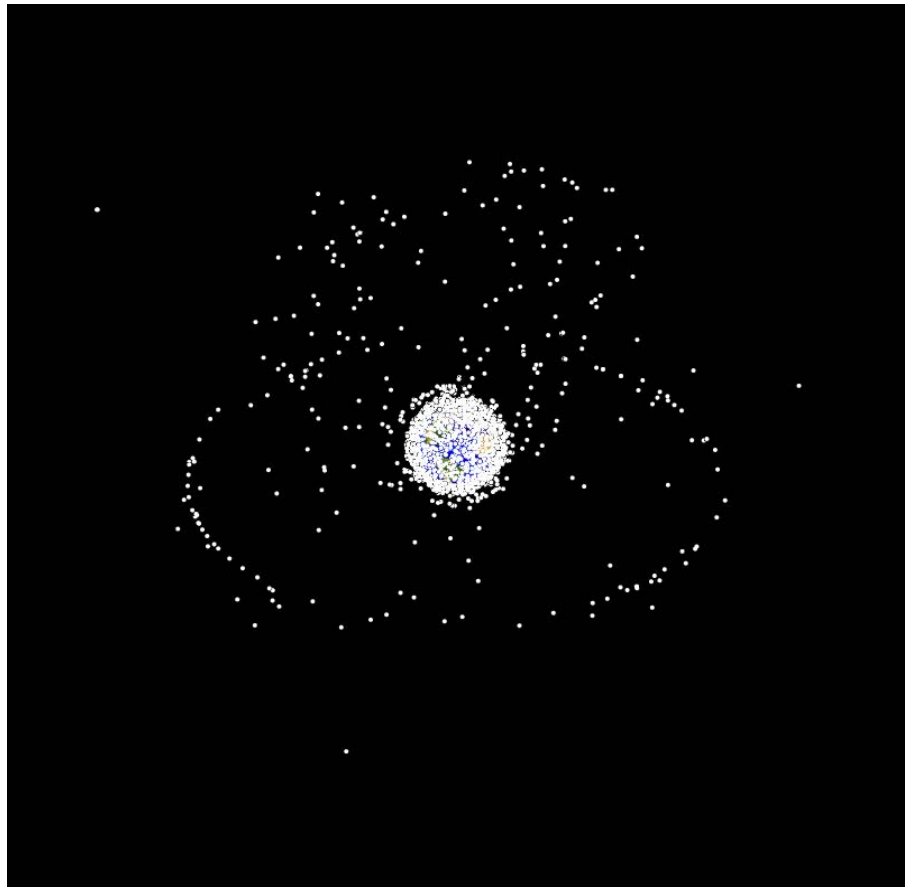


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1980

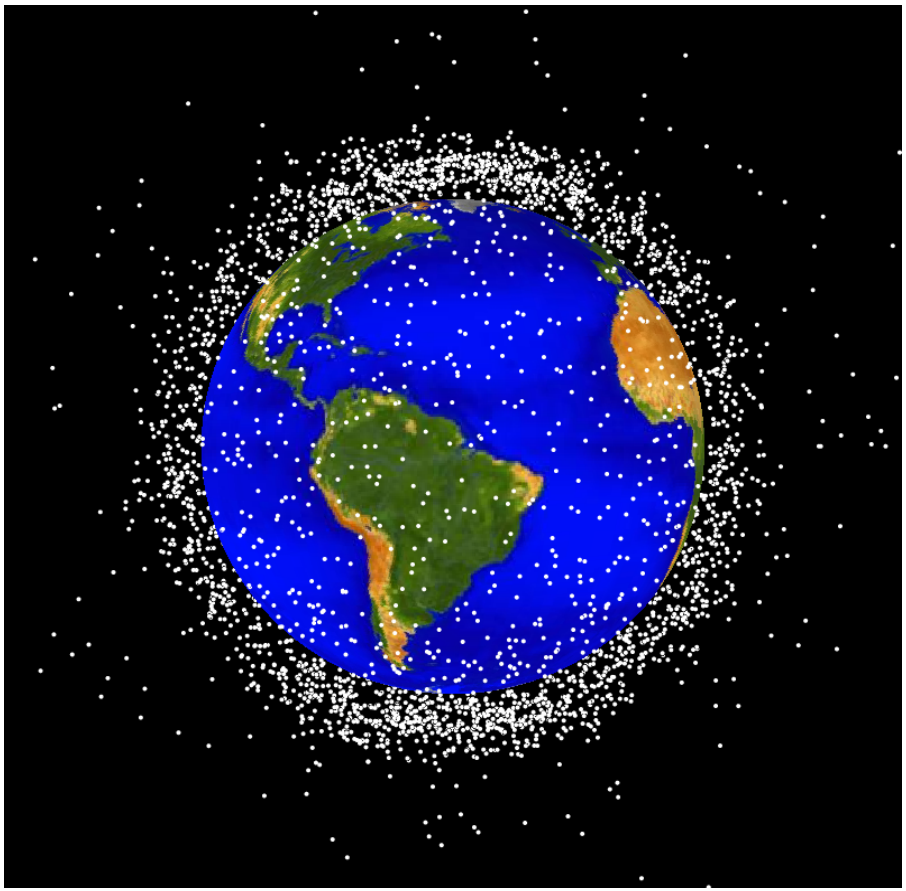


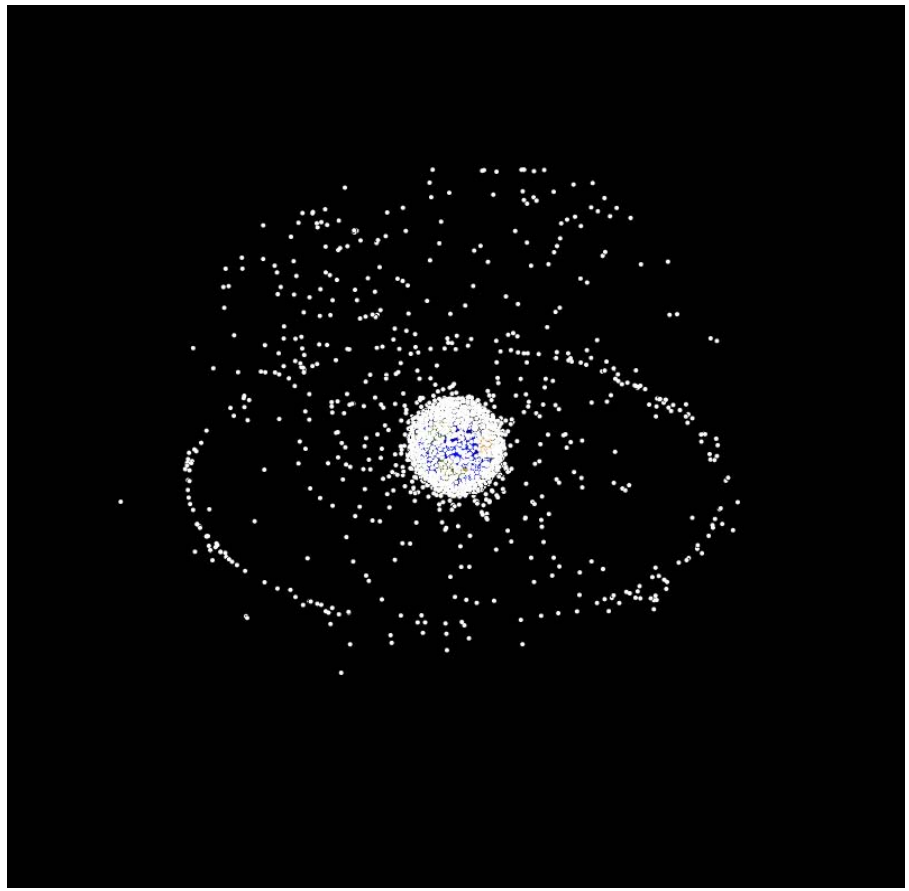


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1985

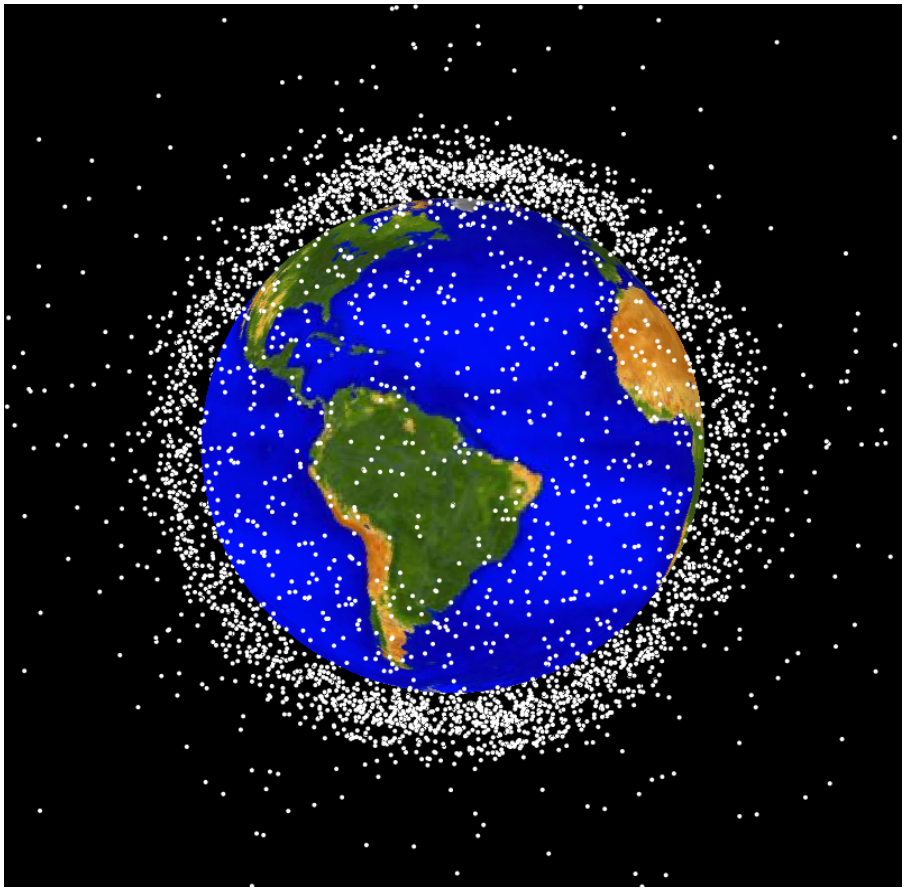


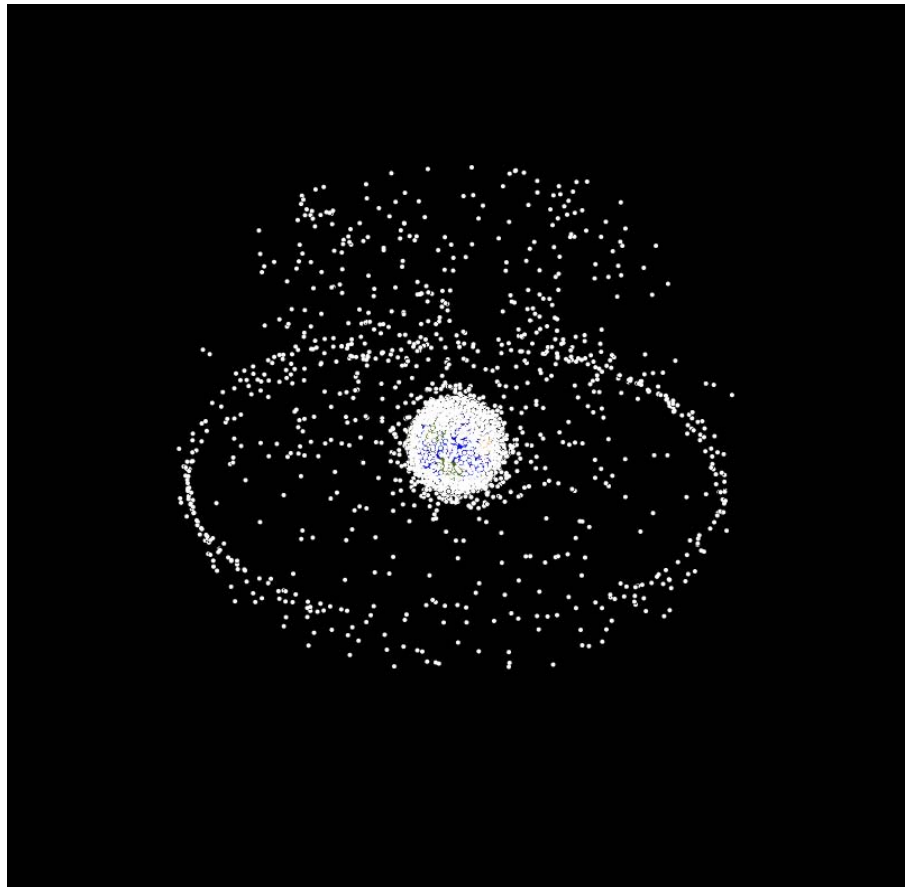


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1990

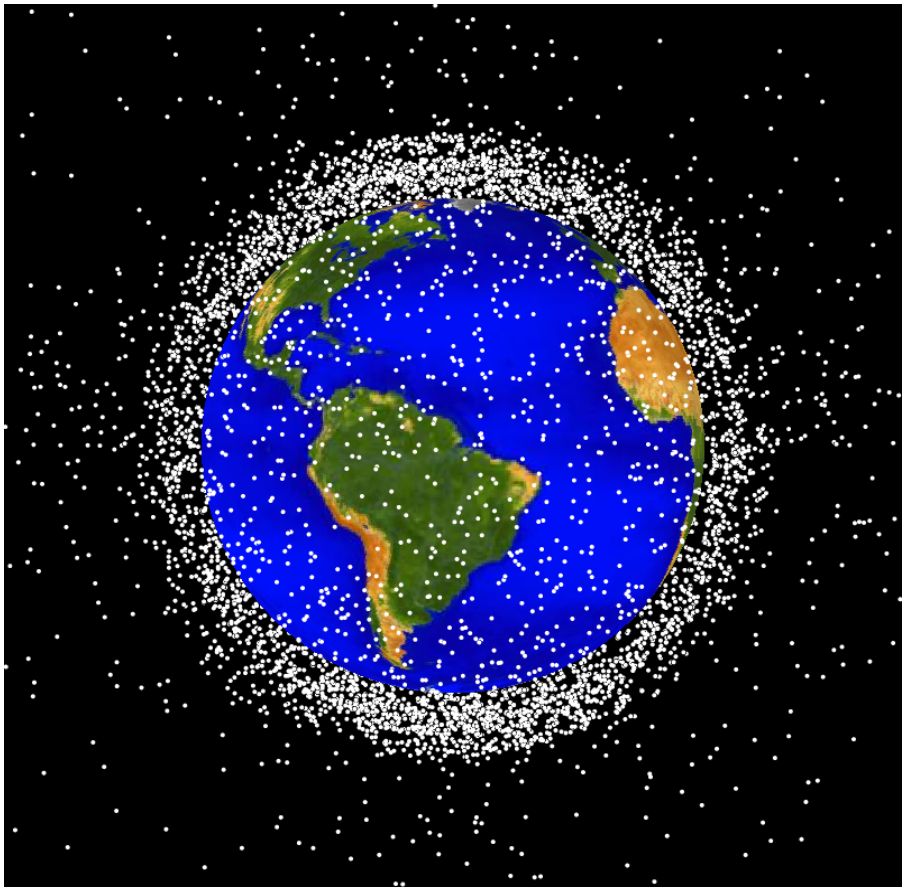


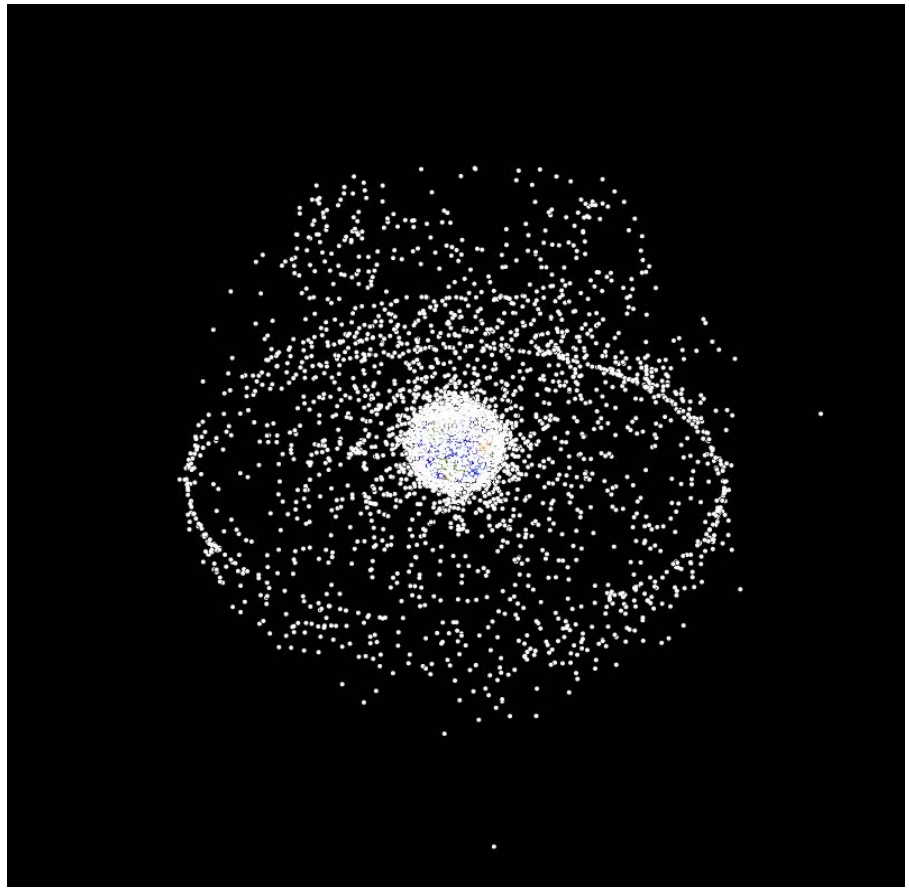


Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

1995

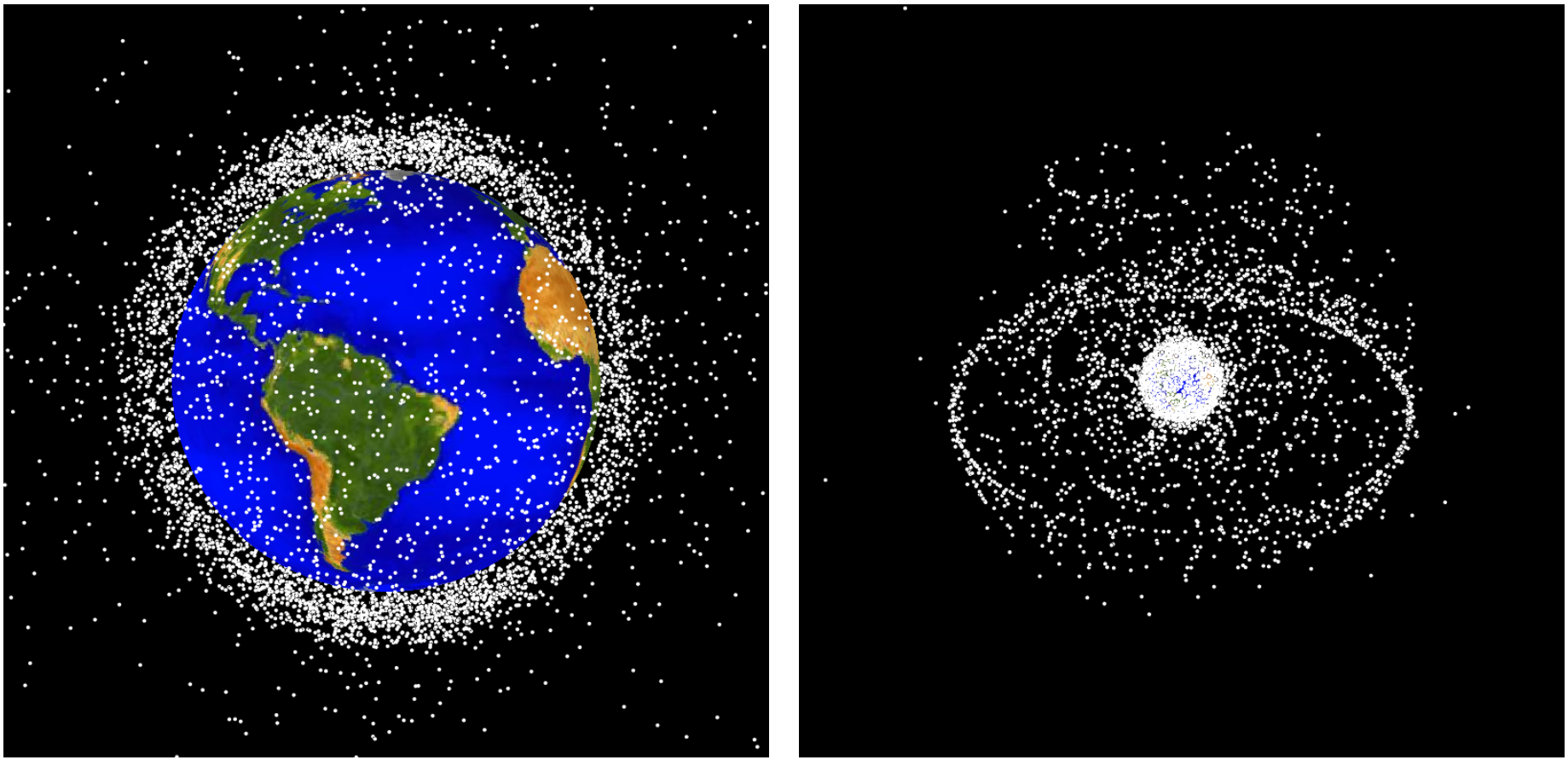




Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

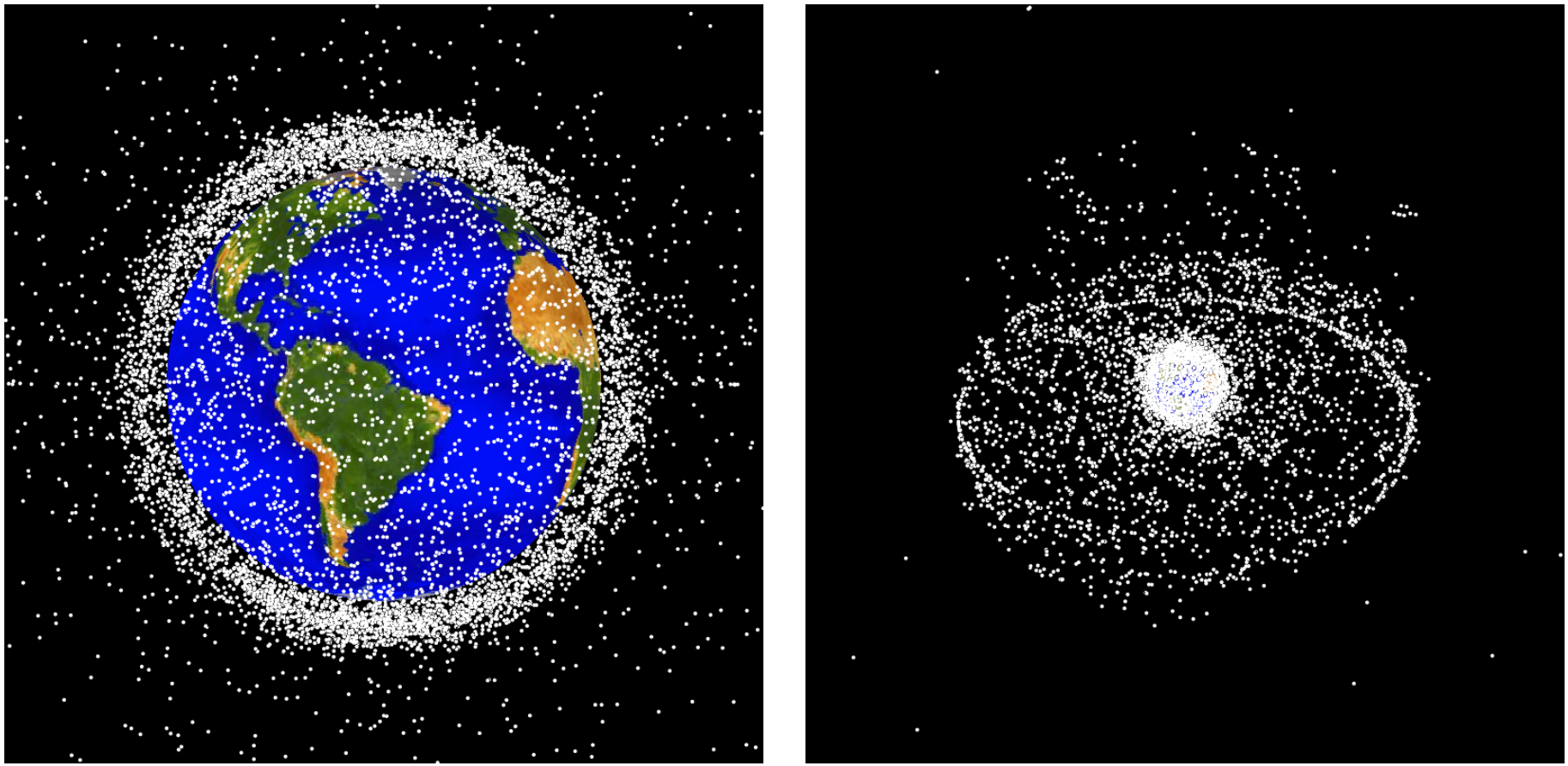
2000



Cataloged objects >10 cm diameter

Growth of the Earth Satellite Population

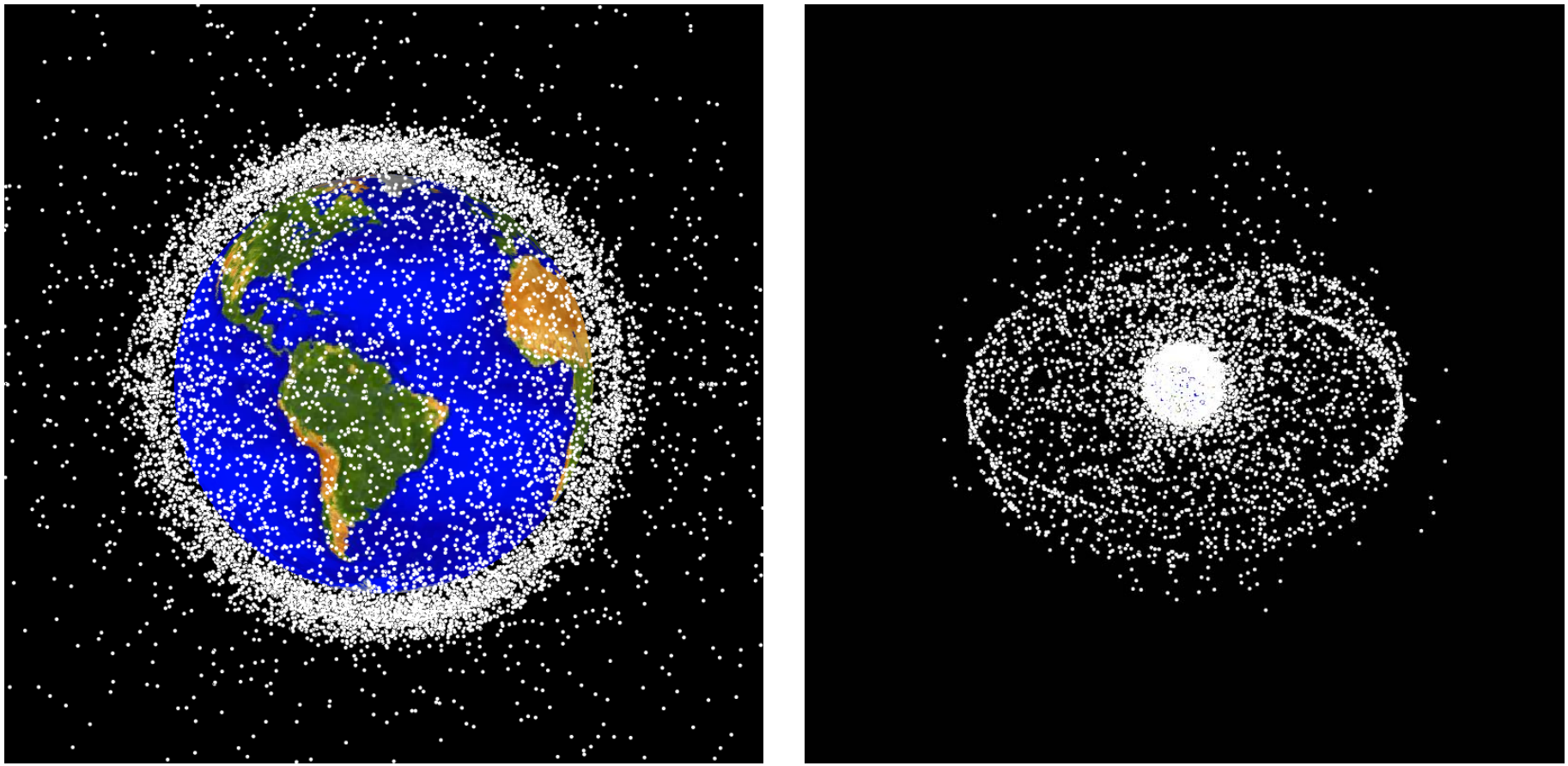
2005



Cataloged objects >10 cm diameter

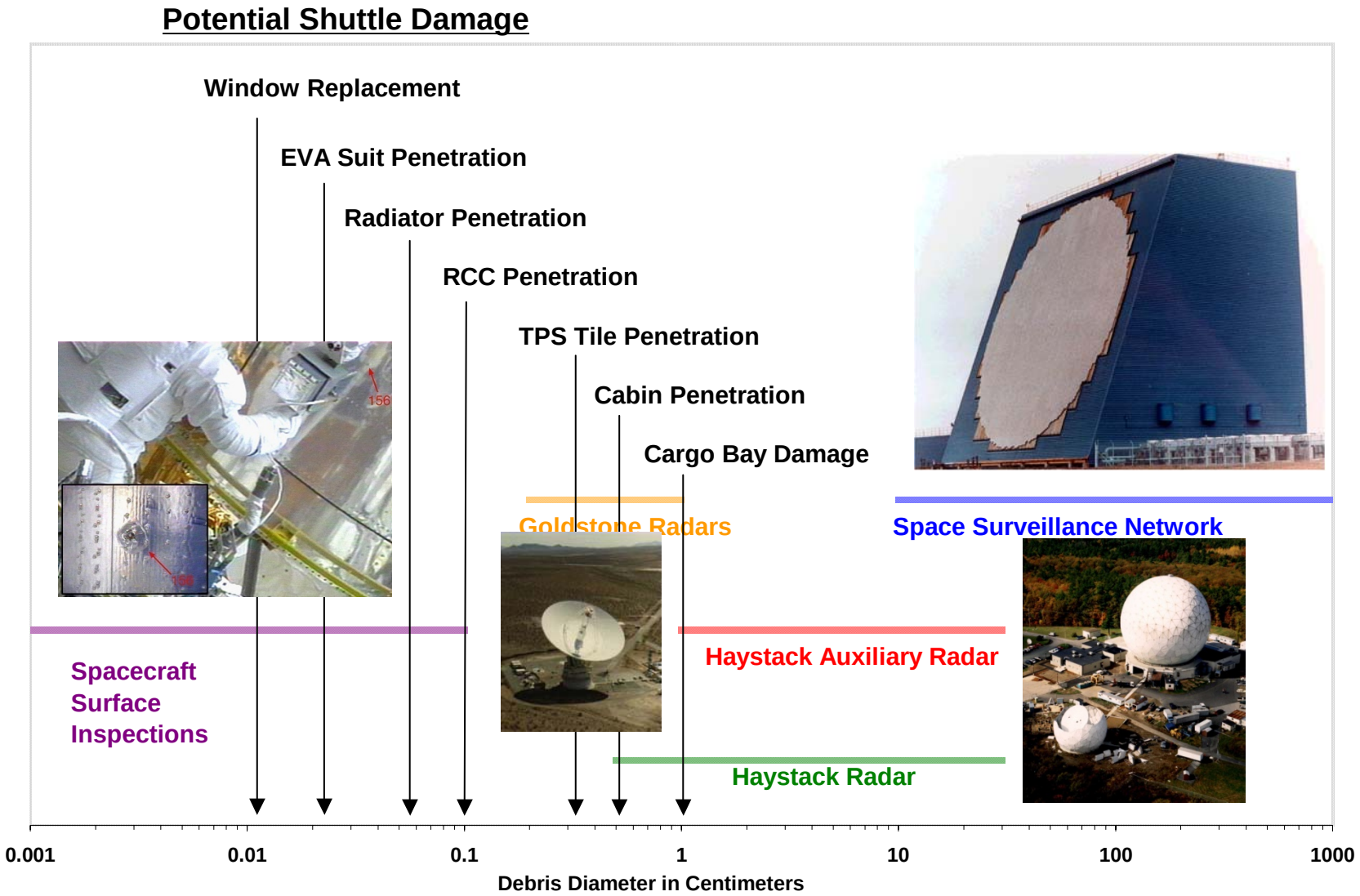
Growth of the Earth Satellite Population

January 2009



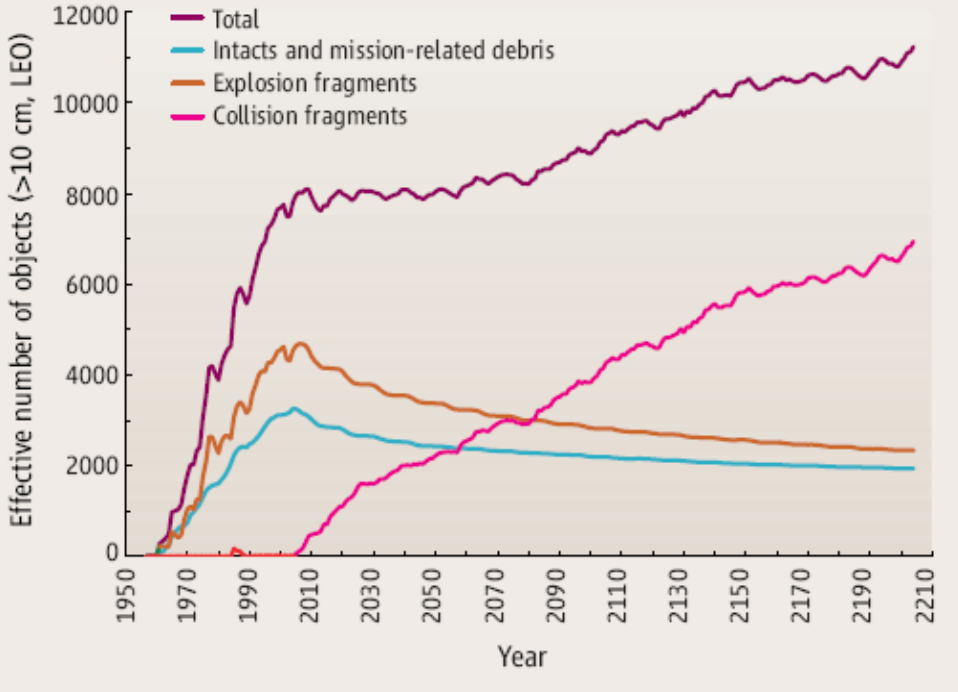
Cataloged objects >10 cm diameter

Principal Orbital Debris Data Sources



LEGEND

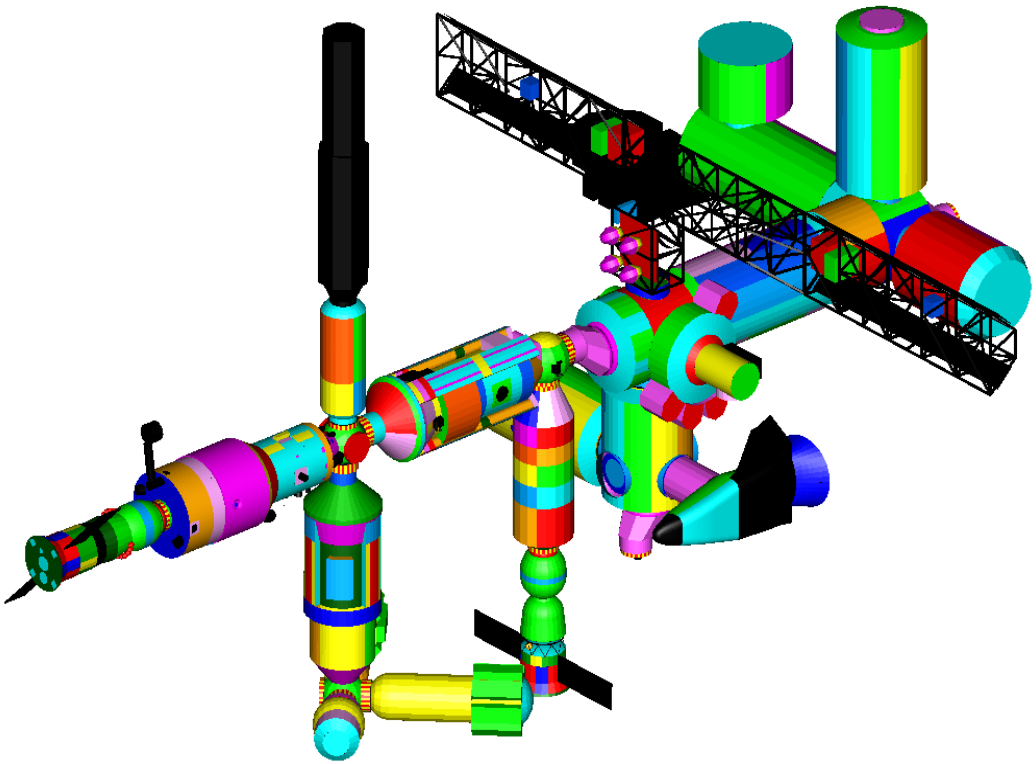
(A LEO-to-GEO Environment Debris Model)

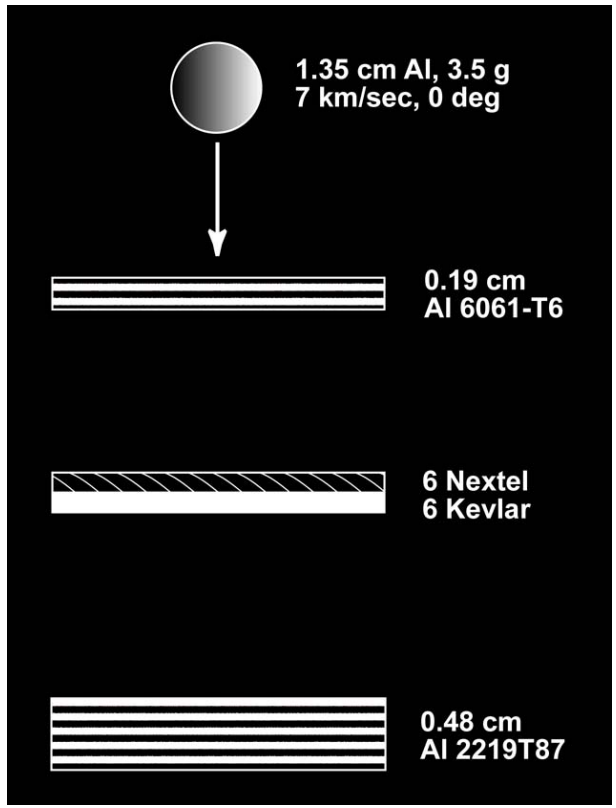


Growth of future debris populations. Effective number of LEO objects, 10 cm and larger, from the LEGEND simulation. The effective number is defined as the fractional time, per orbital period, an object spends between 200- and 2000-km altitudes. Intacts are rocket bodies and spacecraft that have not experienced breakups.

Shielding the International Space Station

The International Space Station is the most heavily protected space vehicle with more than 200 different types of shields to mitigate the effects of small particle hypervelocity impacts.

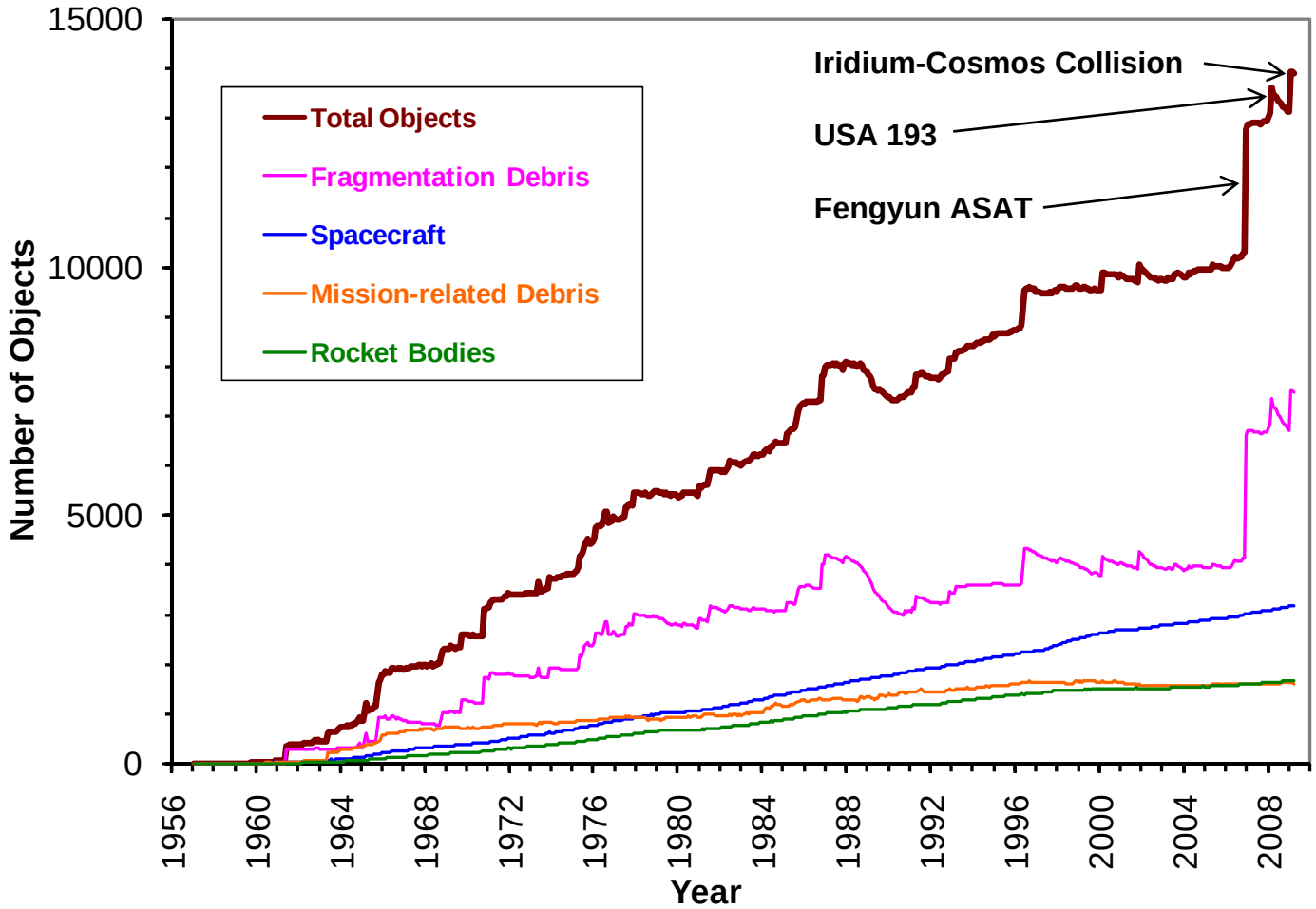




One of 200+ design configurations

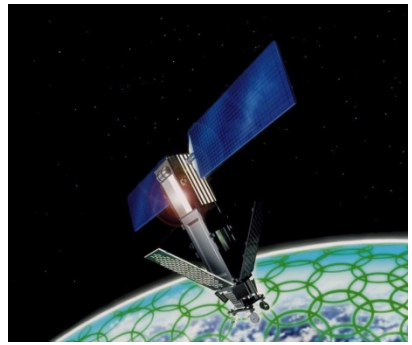
Effect of Recent Collisions on the Cataloged Population

- Number of cataloged objects has increased by more than 30% since 1 January 2007
- Catalog currently has more than 14,000 objects in orbit



Collision of Iridium 33 and Cosmos 2251

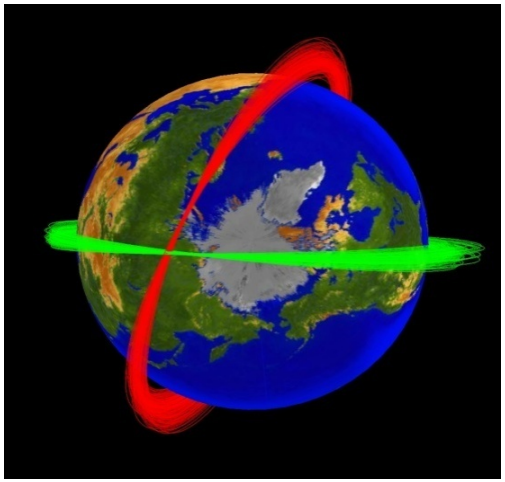
- The first accidental collision between two large intact satellites occurred on 10 February at an altitude of ~790 km.
- The SSN continues to catalog debris from the collision. Close to 900 objects have been cataloged to date.
- There is an approximate 2-to-1 ratio in the number of Cosmos debris to Iridium debris.
- Preliminary results indicate other differences between the two debris clouds.



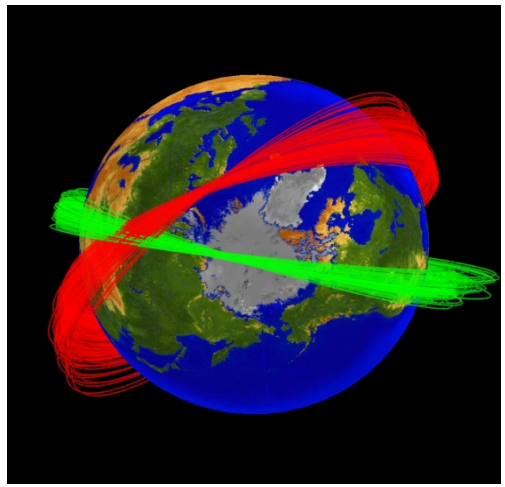
Iridium 33

Cosmos 2251

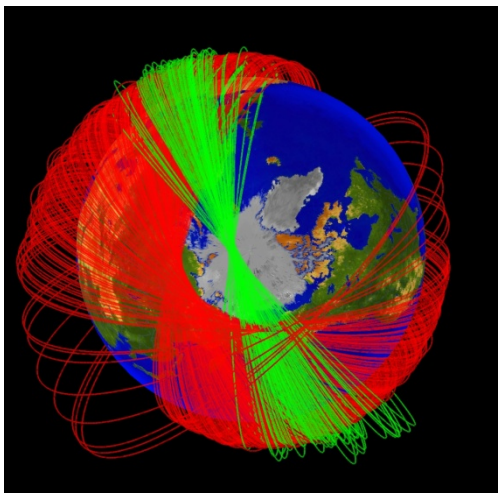
Anticipated Evolution of Collision Debris Clouds



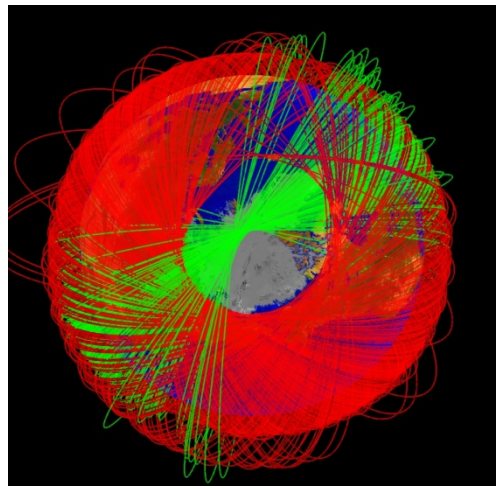
7 Days



30 Days



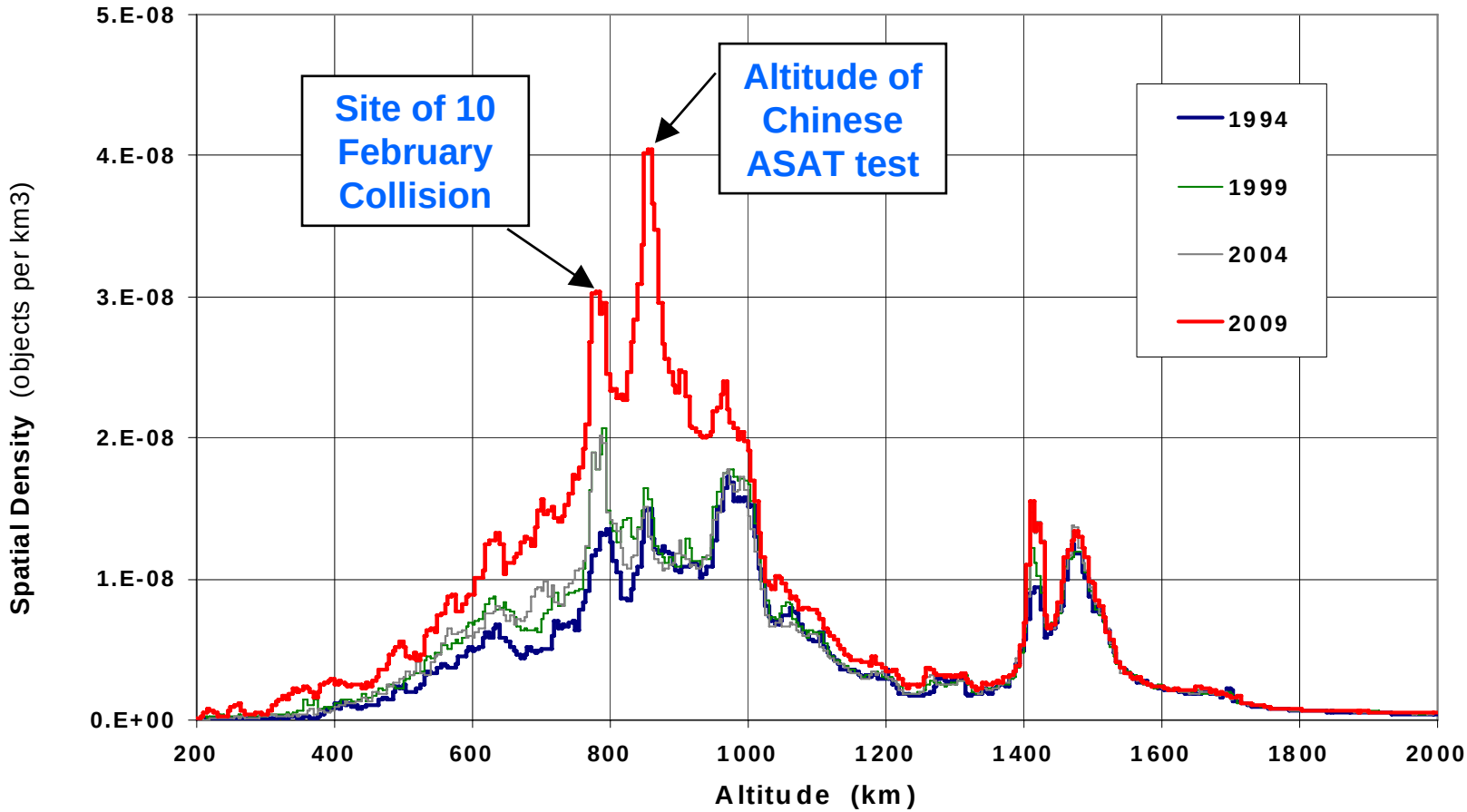
6 Months



1 Year

Recent Growth of Satellite Population in Low Earth Orbit

The growth of the cataloged satellite population during the past 15 years has been primarily influenced by China's ASAT test in January 2007.



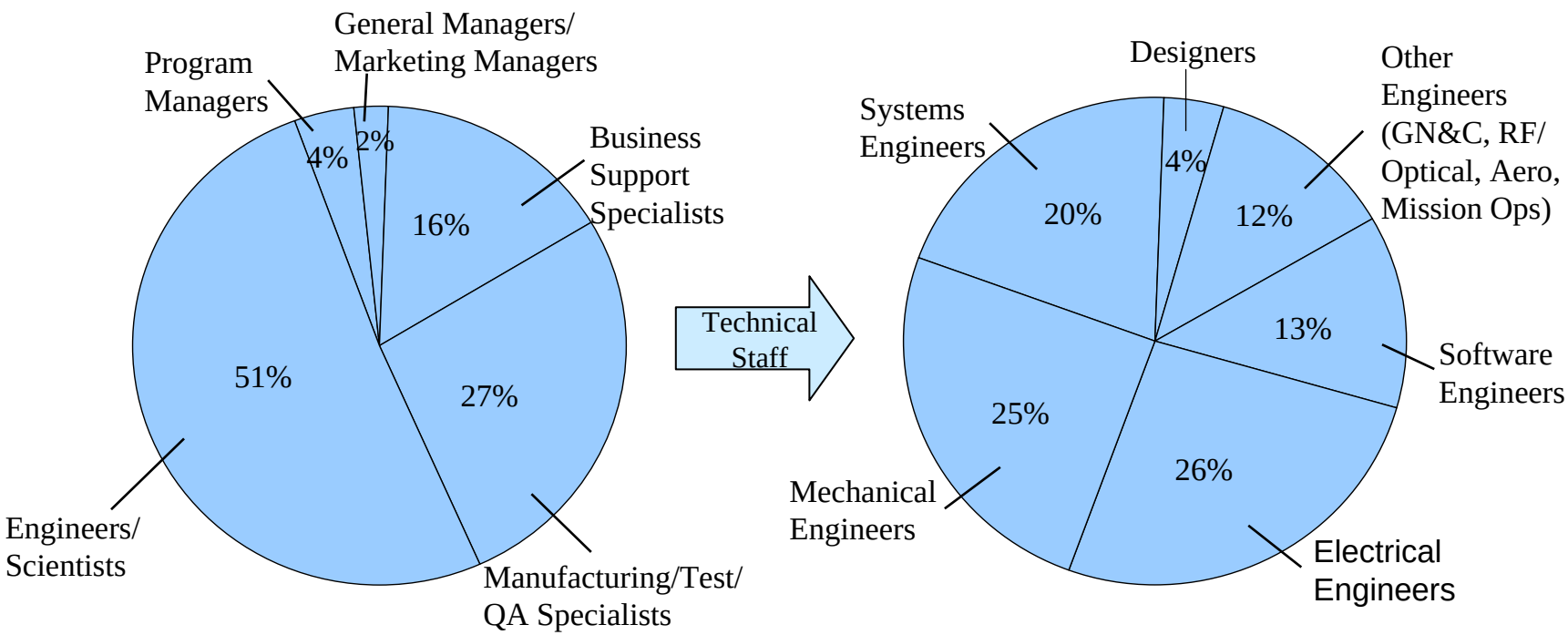
Summary

- The population of debris in orbit continues to grow.
- Since January 2007, the number of cataloged orbital debris objects has increased by more than 30%.
- Example: ISS conjunction in March 2009
- Long-term solutions to the orbital debris environment are still needed.
- Several high profile events have raised the awareness of orbital debris issues providing an opportunity to examine a more aggressive program.
- Recommendation

Orbital Sciences Corp. Overview

- Space Operations Committee visited on April 14, 2009
- Leading Developer and Manufacturer of Smaller Satellites and Launch Vehicles
  - Focus on Growing Market Niches Not Well Served By Larger Companies
  - Provide Highly-Reliable Systems on Fast Schedules and at Affordable Prices
- About 890 Satellites and Launch Vehicles Built or On Contract for Customers
  - 690 Systems Developed, Built and Delivered From 1982 to 2008
  - 200 Systems Under Contract for Deliveries From 2009 to 2015
- 3,700 Employees and 1.25 Million Square Feet of State-of-the-Art Facilities
- Over $5.8 Billion Total Contract Backlog With Premier Customers
- Revenues of $1.17 Billion in 2008, Aiming for ~10% Annual Long-Term Growth
- Conservative Balance Sheet, Strong Cash Flow and Liquidity

High-Caliber Engineering-Centric Workforce



3,700 Employees*

1,875 Engineers/Scientists*

*As of April 1, 2009

Commercial Orbital Transportation Service (COTS) And Commercial Resupply Service (CRS)

Orbital COTS Systems Architecture

The Orbital COTS System is comprised of 4 Major Elements

Cygnus Visiting Vehicle

Orbital COTS System

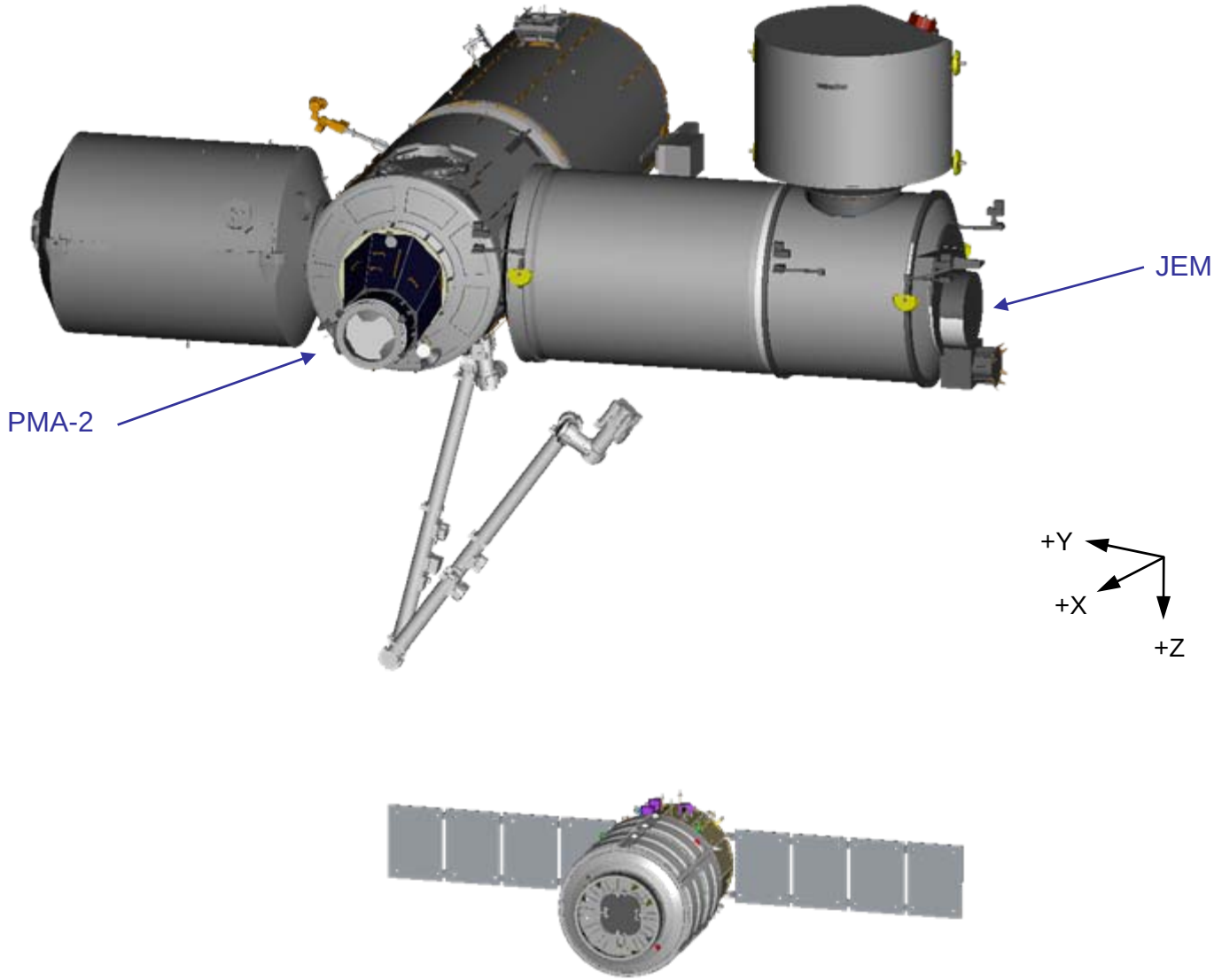
Taurus II

Cargo Operations

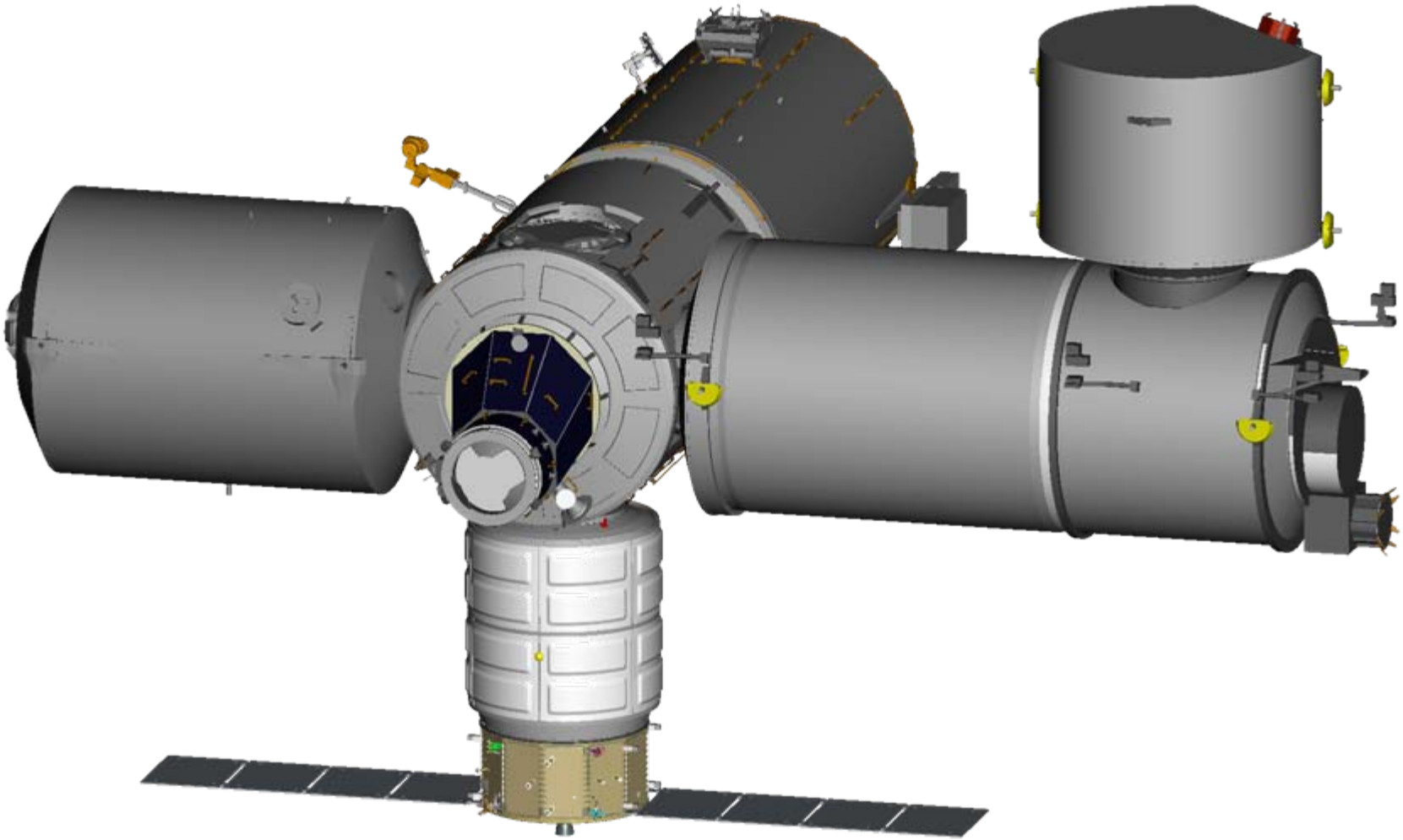
Mission Operations

Integrated Launch Site Operations

Cygnus Visiting Vehicle (Free Flight)



Cygnus Berthed at ISS Node 2



Demonstration and Operational Phase

- Orbital On Contract For Eight Operational Missions Between 2011 And 2015
- CRS Missions Carry Pressurized Cargo To ISS And Disposal Cargo From ISS
- CRS Missions Three Through Eight Provide Enhanced Capability
  - Cygnus Will Utilize A Larger PCM To Provide 2700 Kg Cargo Capacity
  - Taurus II Will Utilize Enhanced Second Stage
  - Cygnus Service Module Design Is Common

Taurus II Launch Sites

LAUNCH SITES

Wallops Flight Facility is Baseline Launch Site for Initial Taurus II Launches, Supporting COTS/CRS
However Taurus II Vehicle is Compatible with Multiple U.S. Launch Ranges Providing Customers with a Variety of Capabilities

Kodiak Launch Complex (KLC)

- KLC in Alaska Provides Taurus II with a Prime Location for Launching High Inclination, Sun-Synchronous Missions

Vandenberg Air Force Base (VAFB)

- VAFB in California is a Another Prime Location for High Inclination, Sun-Synchronous Launches

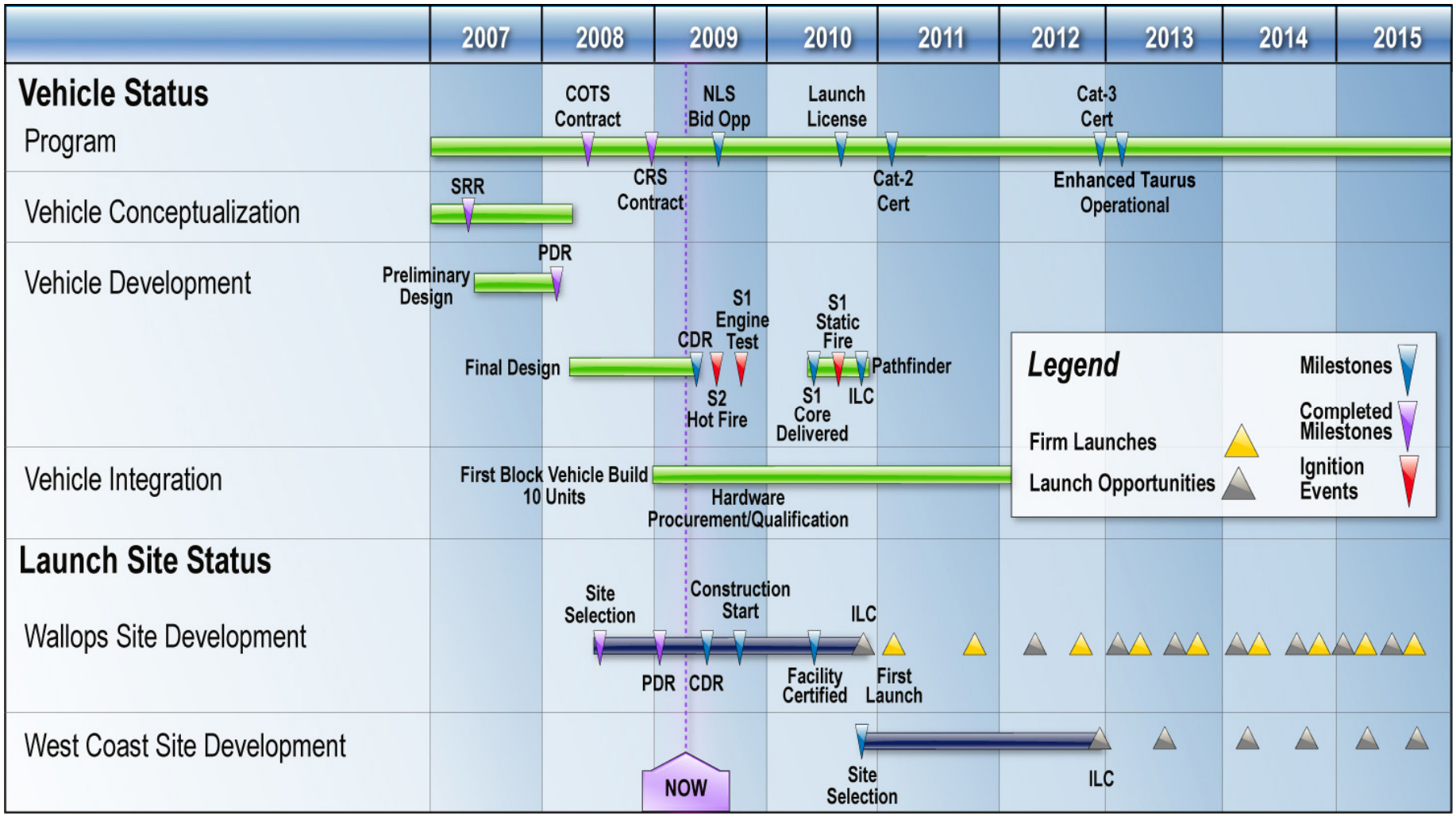
Wallops Flight Facility (WFF)

- NASA's WFF in Virginia is Home to the Taurus II COTS/CRS Launch Program and Supports Mid-Inclination and High Energy Missions

Cape Canaveral Air Force Station (CCAFS)

- CCAFS in Florida Along with NASA's Kennedy Space Center Provides Taurus II with a Veteran Launch Location for Low-Inclination and Specialized Missions

Taurus II Schedule and Manifest




Orion Launch Abort System
NASA

Summary of Accomplishments 2008/09

Major Accomplishments

- ✓ Completed Major Development Testing
- ✓ Completed Structures Fabrication
- ✓ Completed Second Full Scale Jettison Motor Static Fire Test On Schedule
- ✓ Successful Abort Motor Static Fire Test
- ✓ Successful LAS Modal Test
- ✓ Successfully Supported PDR Activities
- ✓ Meeting Both PA-1 and Operational LAS Mass Requirements
- ✓ GFY08 Expenditures Came In Under The Required Limit
- ✓ Successful ACM HT-6 Test
- ✓ Successful ACM HT-8A Test

Second Jettison Motor Full Scale Test

Abort Motor Full Scale Test

Control Motor Structural Development Unit

LAS Modal Test

Attitude Control Motor HT-8A Test

Orbital Sciences Corp. Facility Visit

Summary

- The Space Ops Committee has now visited the facilities of both COTS companies, SpaceX and Orbital Sciences Corp., and is pleased to report positive progress in both cases.

U.S. Research on ISS National Lab

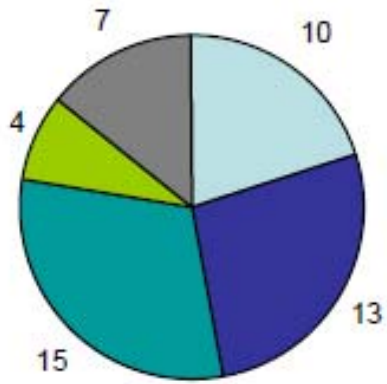
ISS National Laboratory beginning in 2010 (NASA Authorization Acts of 2005 and 2008)

- Opportunities for other U.S. government agencies to use ISS to meet their agency objectives
- Opportunities for commercial interests to use ISS in the interests of economic development in space
- SAA in place with NIH

Expedition 19/20 Research Plans

(April 2009 – October 2009, data as of Feb 17, 2009)

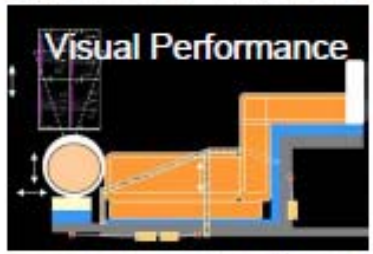
- Expedition 19/20
  - 98 U.S.-integrated investigations
    - 39 new investigations
    - 49 International Partner investigations
      - 5 CSA
      - 28 ESA
      - 16 JAXA
  - > 400 scientists



Expedition 19/20

Disciplines for U.S. Science

- Human Research for Exploration
- Technology Development
- Physical Sciences
- Biological Sciences
- Earth Observation & Education



NASA Research Outfitting

2 Human Research Facility Racks

6 ExPRESS Racks

Microgravity Science Glovebox (MSG)

Minus Eighty-Degree Laboratory Freezer for ISS (MELFI)

Combustion Integrated Rack (CIR)

2001-2008

Materials Science Research Rack

Window Observational Research Facility

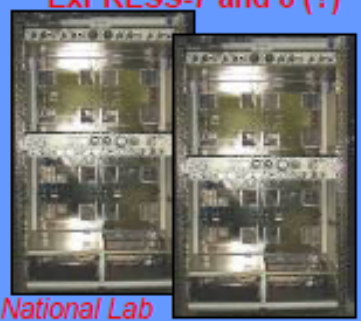
Muscle Atrophy Research Exercise System (MARES)

Fluids Integrated Rack (FIR)

MELFI-3

MELFI-2

ExPRESS-7 and 8 (?)



Added for National Lab

2009

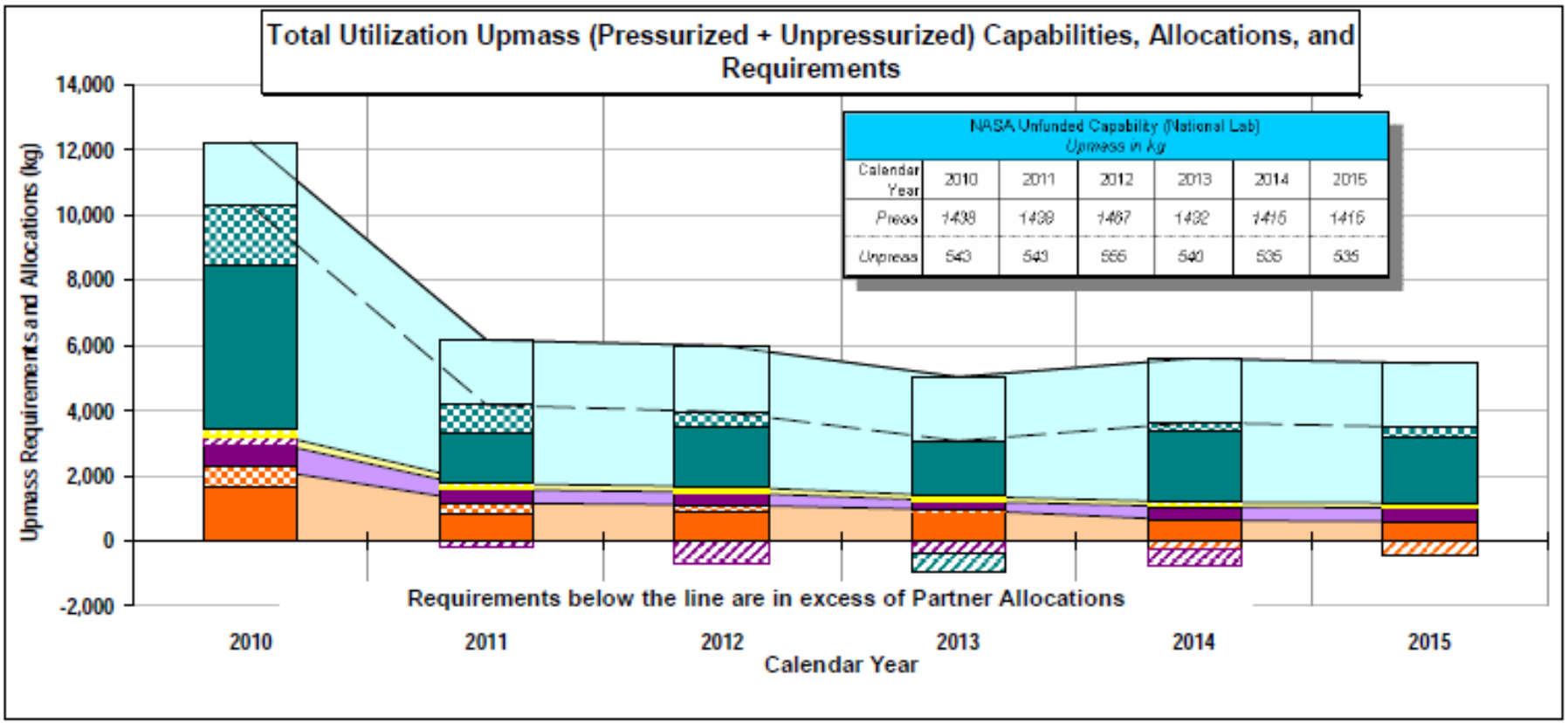
2010

Partner Utilization Requirements Compared to Utilization Capabilities

Upmass

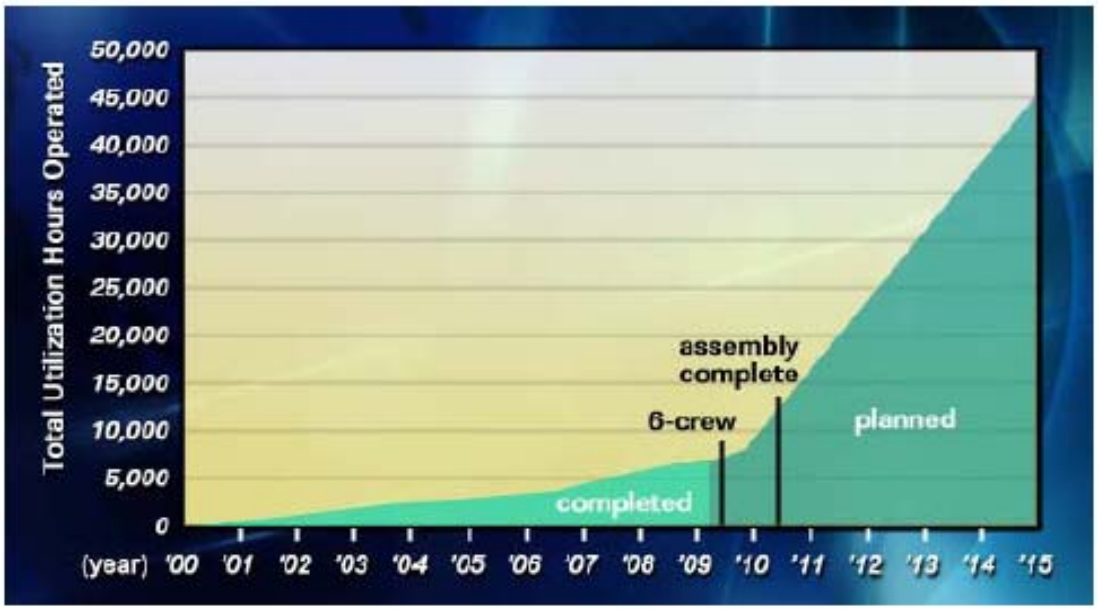
2008 Signed Consolidated Operations and Utilization Plan.
Assembly Sequence Rev J

	Capabilities	Requirements met by Allocation	Unused Allocation	Requirements not met by Allocation
NASA/US National Lab			N/A	N/A
NASA Utilization				
CSA				
ESA				
JAXA				
USOS Planned Capability*				
NASA Utilization Capability				



Importance of 6-crew for Utilization

- Availability of Human Subjects
  - Each subject can participate in approximately 6 experiments
    - Limitations on Baseline Data Collection (BDC), especially in first week post-return
    - Interactions of experimental and control treatments for multiple experiments
  - Transition from 3- to 6-crew doubles available human subjects for human research experiments
- Increases Total Crewtime for Research



Recommendation

Recommendation:

We recommend that NASA conduct an in-house study of the current and projected orbital debris situation in order to evaluate the costs and benefits of developing a form of debris removal technology. The study should compare the costs of operating in the ever-expanding debris population with those of developing a selective debris removal method, and how those compare with long-term savings from actively reducing the threat of future collisions. We also recommend that NASA examine enhancements to the nation's debris detection, tracking, and prediction capabilities that will enhance spacecraft protection.

Rationale:

The growing debris population, expanded significantly by recent ASAT tests and random collisions, poses a continuing and increasing threat to operational spacecraft. Despite international protocols on preventing the creation of future debris, the debris population will continue to expand for decades, well past the middle of the century. Gaps exist in U.S. detection capabilities, especially at smaller debris sizes that can still cause catastrophic damage to spacecraft. The projected debris population will, over decades, result in additional damage to or loss of spacecraft, and poses a growing threat to spacecraft. NASA may be able to offer methods to actively reduce the debris population. The benefits of reducing the debris population will accrue to commercial, military, and NASA spacecraft.

Activities for Next Quarter

Fact finding:

- Human/Machine Interface of Orion for both ISS and Lunar missions
- Orion Water vs Land Landing (with Exploration Committee)
- Constellation Deep Space Operations beyond the Moon (e.g. NEOs) (with Exploration Committee)
- Ames work on handling qualities for Moon/Mars landers

Activities:

- Attend Aerospace Safety Advisory Panel briefing at JSC (April 2009)

Summary of Activities

- ISS Status
- Space Shuttle Manifest Update
- Orbital Debris Update
- Orbital Sciences Corporation Facility Visit
- ISS Research Program Plan Update